USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Rocky Mountain Region Forest Health | R2–RO–24-01 | January 2024

Forest Insect and Disease Conditions in the Rocky Mountain Region, 2023

Disclaimers for Aerial survey data, GIS and Maps

Due to the nature of aerial surveys, these data will only provide rough estimates of the location, intensity and resulting trend information for agents detectable from the air. Many of the most destructive diseases are not represented in the data because these agents are not detectable from aerial surveys. The maps and data presented should only be used as a partial indicator of insect and disease activity and should be validated on the ground for actual location and causal agent. The insect and disease data are available digitally from the USDA Forest Service, Region Two Forest Health Protection (FHP) group. The cooperators reserve the right to correct, update, modify, or replace GIS products. Using these data for purposes other than those for which they were intended may yield inaccurate or misleading results.

The information shown is based on data compiled as of December 2023.

Cover photo: Aerial view of roundheaded pine beetle complex activity spreading from the Glade on the Dolores Ranger District on the San Juan National Forest. Photo by Matthew Ethington USDA-FS.

Contents

Conditions in Brief

2023 Weather Summary for the Rocky Mountain Region

In 2023, the USDA Forest Service (USDA-FS) Rocky Mountain Region (Region 2 or R2) experienced more precipitation than average in many areas (Figure 1). The snowpack throughout much of the region was well above normal. The spring and early summer brought relatively cool temperatures and stormy conditions with Colorado reporting the 31st stormiest year since 1896 when records began. Many of these storms also brought hail with record numbers of hail storms reported in Colorado. As the summer progressed parts of the region began to see the extreme heat events that much of the rest of north America was experiencing. Many places in the western parts of the region recorded daily maximum temperature records while some eastern portions remained mild.

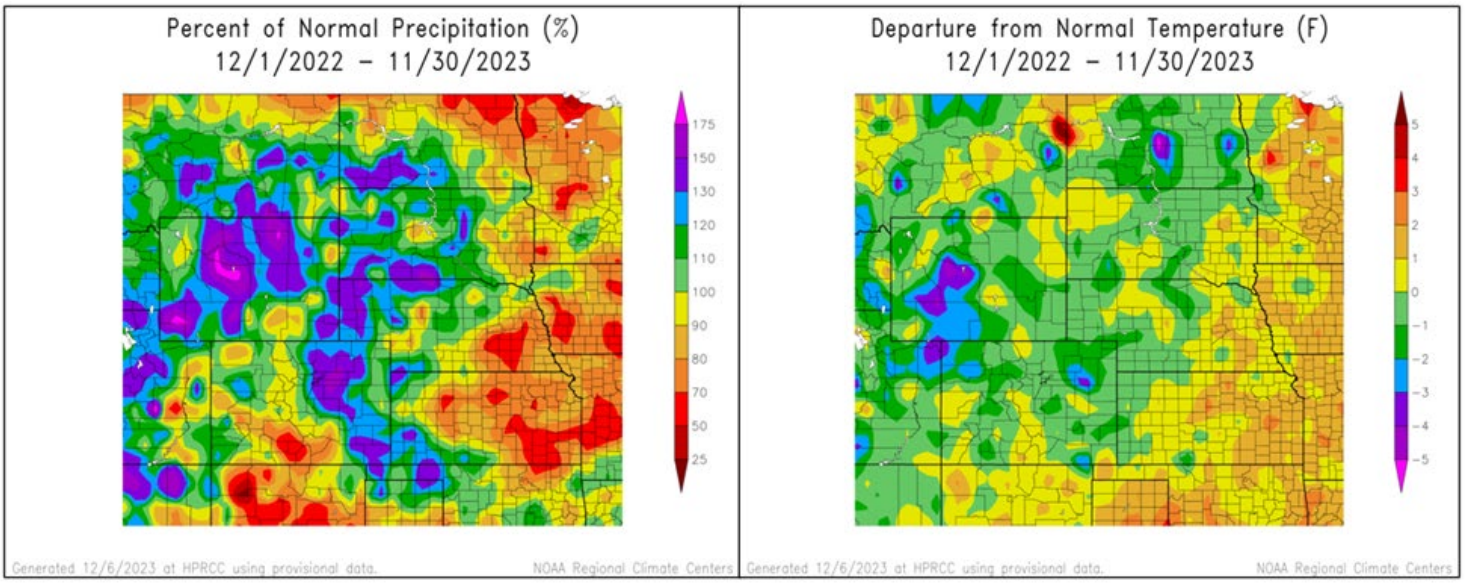

Figure 1. Percent of normal precipitation (left) and departure from normal temperature (right) for Region 2. Source: High Plains Regional Climate Center.

Aerial Survey Summary

Each year during the summer and early fall, the R2 USDA-FS State, Private and Tribal Forestry (SPTF) group, Forest Health Protection (FHP) and its state partners conduct aerial detection surveys to map forest insect and disease activity in R2. Aerial surveys provide an annual snapshot of forest health conditions over large areas more efficiently and economically than other methods. To conduct the survey, observers in small aircraft record areas of activity using a digital aerial sketch mapping system that incorporates a tablet computer, geographic information systems and global positioning system technology. Aircraft used for these flights in Region 2 are typically small high-wing planes such as the Quest Kodiak 100 and Cessna T206. Aircraft fly in either a grid pattern over relatively flat terrain or following the contours of the terrain in mountainous or deeply dissected landscapes. The USDA-FS partners with state cooperating agencies in conducting the annual survey. In 2023, 45,665,841 acres were surveyed in R2 (Figure 2).

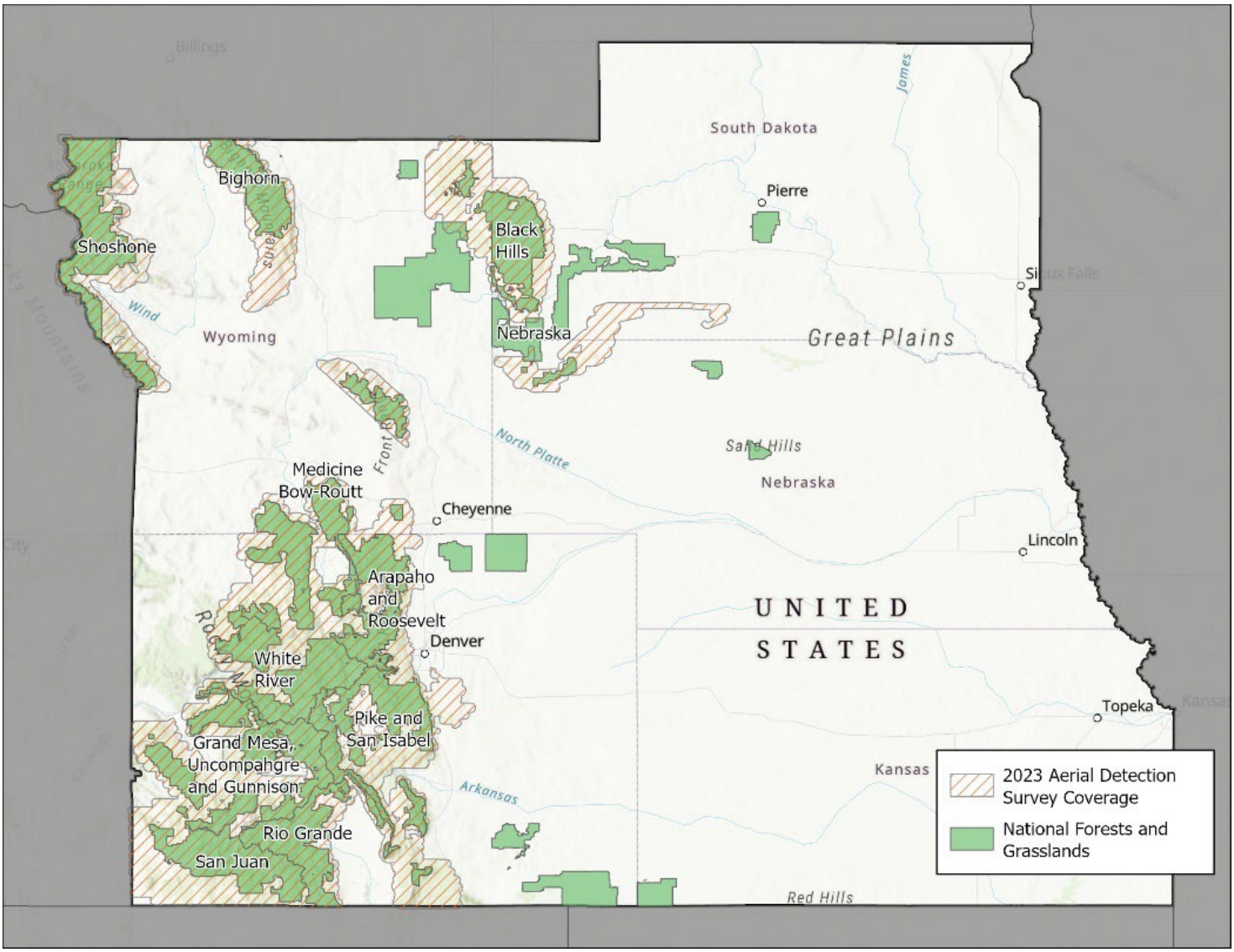

Figure 2. Flown areas from the 2023 aerial detection survey. Map by Nathan Edberg, USDA-FS.

Bark Beetle Summary

The majority of new tree mortality observed in the Rocky Mountain Region was attributed to these primary bark beetles: spruce beetle, Douglas-fir beetle, western balsam bark beetle and mountain pine beetle. Heavy western spruce budworm defoliation contributed to continued Douglas-fir beetle activity in the Region. Individual bark beetle species' activity increased for Douglas-fir beetle and mountain pine beetle and decreased for western balsam bark beetle and spruce beetle.

Forest Health Protection specialists conducted ground surveys in new areas of mountain pine beetle activity along the Front Range of Colorado and in the northern Black Hills of South Dakota and Wyoming both to verify and expand upon aerial survey data.

Table 1. Comparison of acres of bark beetle[1] activity observed by state from aerial detection surveys between 2022 and 2023 in Region 2.

State	Spruce Beetle	Spruce Beetle	Mountain Pine Beetle	Mountain Pine Beetle	Douglas-fir Beetle	Douglas-fir Beetle	Western Balsam Bark Beetle	Western Balsam Bark Beetle
Year	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
Colorado	29,000	19,000	2,400	3,100	9,700	17,000	35,000	27,000
Kansas	0	0	0	0	0	0	0	0
Nebraska	0	0	0	0	0	0	0	0
South Dakota	0	0	40	330	0	0	0	0
Wyoming[2]	5,000	2,800	70	550	330	350	5,900	4,100
Region 2 Total[3]	**34,000**	**22,000**	**2,500**	**4,000**	**10,000**	**18,000**	**41,000**	**31,000**

[1]Only major bark beetle and mortality agents are shown. Agents detected with lesser activity may not be represented in the table.
[2]Includes only the Region 2 portion of Wyoming.
[3]Sum of individual values may differ from totals due to rounding and multiple agents occurring in the same location.

Table 2. Bark beetle[1] activity by National Forest (NF) in acres from aerial detection surveys in 2023.

National Forest[2]	Spruce Beetle	Mountain Pine Beetle	Douglas-fir Beetle	Western Balsam Bark Beetle	Roundheaded Bark Beetle complex in Ponderosa Pine
Arapaho and Roosevelt NF	270	90	310	2,100	0
Bighorn NF	170	100	20	150	0
Black Hills NF	0	650	0	0	0
Grand Mesa, Uncompahgre and Gunnison NF	3,600	1,400	2,800	5,600	1500
Medicine Bow and Routt NF	680	6	50	5,200	0
Nebraska NF	0	0	0	0	0
Pike and San Isabel NF	6,200	430	2,900	730	0
Rio Grande NF	60	40	3,700	50	0
San Juan NF	5,700	5	2,200	990	3,300
Shoshone NF	2,600	10	300	410	0
White River NF	100	4	1,200	6,800	0

[1]Only major bark beetle and mortality agents are shown. Agents detected with lesser activity may not be represented in the table.
[2]Values based on administrative forest (proclamation) boundaries, thus any inholdings within the Forest boundary are included.

Defoliation and Abiotic Injury Summary

Defoliation can be caused by insects, diseases and abiotic events, including the non-living parts of an ecosystem such as weather, light and water. Due to lighting conditions and smoke, the causal agents of tree defoliation can be difficult to distinguish when conducting aerial surveys. Tree stress caused by multiple years of defoliation can directly lead to tree mortality or predispose trees to bark beetle attack.

Specific abiotic events such as tornadoes and avalanches can cause local catastrophic damage by uprooting and snapping trees. Areas of windthrown trees, the uprooting and overthrowing of a tree caused by wind, may warrant ground monitoring for bark beetle activity depending on the species, the size of the impacted trees and the adjacent stands. This is because trees downed by wind events can provide suitable host material for bark beetles to reproduce, in some cases allowing populations to grow sufficiently that adjacent, healthy trees can be successfully attacked and killed. Notable tornado activity occurred in July 2023 on Pikes Peak in Colorado.

Table 3. Major defoliators, diseases and abiotic[1] activity by state in acres from aerial detection surveys in 2023.

State	Aspen Defoliation and Discoloration[2]	Western Spruce Budworm	Windthrow
Colorado	6,000	202,000	250
Nebraska	0	0	0
Kansas	0	0	0
South Dakota	0	0	0
Wyoming[3]	120	18,000	0
Region 2 Total[4]	**6,100**	**219,000**	**250**

[1]Only major defoliators, diseases and abiotic agents are shown. Agents detected with lesser activity may not be represented.
[2]Aspen defoliation and discoloration include damage primarily by Marssonina leaf spot, western tent caterpillar and large aspen tortrix.
[3]Includes only the Region 2 portion of Wyoming.
[4]Sum of individual values may differ from totals due to rounding and multiple agents occurring in the same location.

Table 4. Major defoliators, diseases and abiotic[1] activity by National Forest (NF) in acres from aerial detection surveys in 2023[2].

National Forest[3]	Aspen Defoliation and Discoloration[4]	Western Spruce Budworm	Windthrow
Arapaho and Roosevelt NF	120	190	0
Bighorn NF	10	760	0
Black Hills NF	0	0	0
Grand Mesa, Uncompahgre and Gunnison NF	1,100	74,000	0
Medicine Bow and Routt NF	170	8,300	0
Nebraska NF	0	0	0
Pike and San Isabel NF	460	31,000	210
Rio Grande NF	1,100	4,100	0
San Juan NF	860	16,000	0
Shoshone NF	0	13,000	0
White River NF	310	29,000	0

[1]Only major defoliators, diseases and abiotic agents are shown. Agents detected with lesser activity may not be represented in the table.
[2]Sum of individual values may differ from totals due to rounding and multiple agents occurring in the same location.
[3]Values based on proclamation boundaries, thus any inholdings within the Forest boundary are included.
[4]Aspen defoliation and discoloration include damage primarily by Marssonina leaf spot, western tent caterpillar and large aspen tortrix.

Disease Summary

Tree diseases can quickly (over weeks) cause tree damage and mortality. However, damage and mortality often occur over several years for many diseases. Tree diseases including dwarf mistletoes, root diseases, rusts and cankers persist for years in forest stands. The typical lifespan of conifers in R2 is 200 to 600 plus years. Damage and mortality occurring over many years often express visual symptoms that can be undetectable by aerial surveys, although the accumulated losses in growth and lumber quality, combined with branch, stem and eventual tree mortality accumulates over the life of trees. Crown discoloration may key aerial surveyors into locations and even trees with disease. However, ground surveys are usually required to identify causal agents. Recent disease outbreaks and other persistent diseases are covered in the chapter *Status of Major Diseases*.

Status of Major Bark Beetles

Mountain pine beetle adult emerging from Ponderosa pine bark.
Photo by Megan Wilson, USDA-FS

Status of Major Bark Beetles

Spruce Beetle

Dendroctonus rufipennis

Hosts: Engelmann and blue spruce, attacks lodgepole pine but does not reproduce.

Spruce beetles, like many of the most destructive bark beetles, find the most suitable hosts in stands of dense, mature and stressed trees. In the last twenty years in many areas in Region 2 where these conditions existed, spruce beetle outbreaks have moved through vast acreages and killed a majority of large diameter Engelmann spruce trees. Ongoing outbreaks of spruce beetle continue to expand where suitable hosts are present in Region 2, particularly in and adjacent to the San Juan, Gunnison, Shoshone, Arapaho/Roosevelt and Medicine Bow National Forests (Figures 3, 4, 5 and 6). However, there was a significant overall reduction in spruce beetle acres mapped by aerial surveys in Colorado and Wyoming in the last few years. In many locations this reduction is the result of spruce beetle outbreaks having moved through areas with abundant suitable host tree availability into areas with fewer host trees, thus activity has subsided due to host depletion. In many areas where beetles have been active in recent years, few mature spruce trees remain living. In areas where spruce beetle has killed most larger diameter spruce trees, smaller diameter spruce, as well as other non-host species such as subalpine fir and quaking aspen, have in most cases survived the outbreaks and continue to occupy these stands.

Figure 3. Fading and standing dead Engelmann spruce trees following spruce beetle attack on the Bighorn National Forest. Photo by Justin Backsen, USDA-FS.

In Colorado, 19,000 acres of spruce beetle activity were observed, which is a third less than in 2022. Spruce beetle activity continues in the San Juan mountains, especially on the north side of Lizard Head Pass and south of Silverton. They also continue to infest areas in the central Sawatch Range and areas west and south of Rocky Mountain National Park.

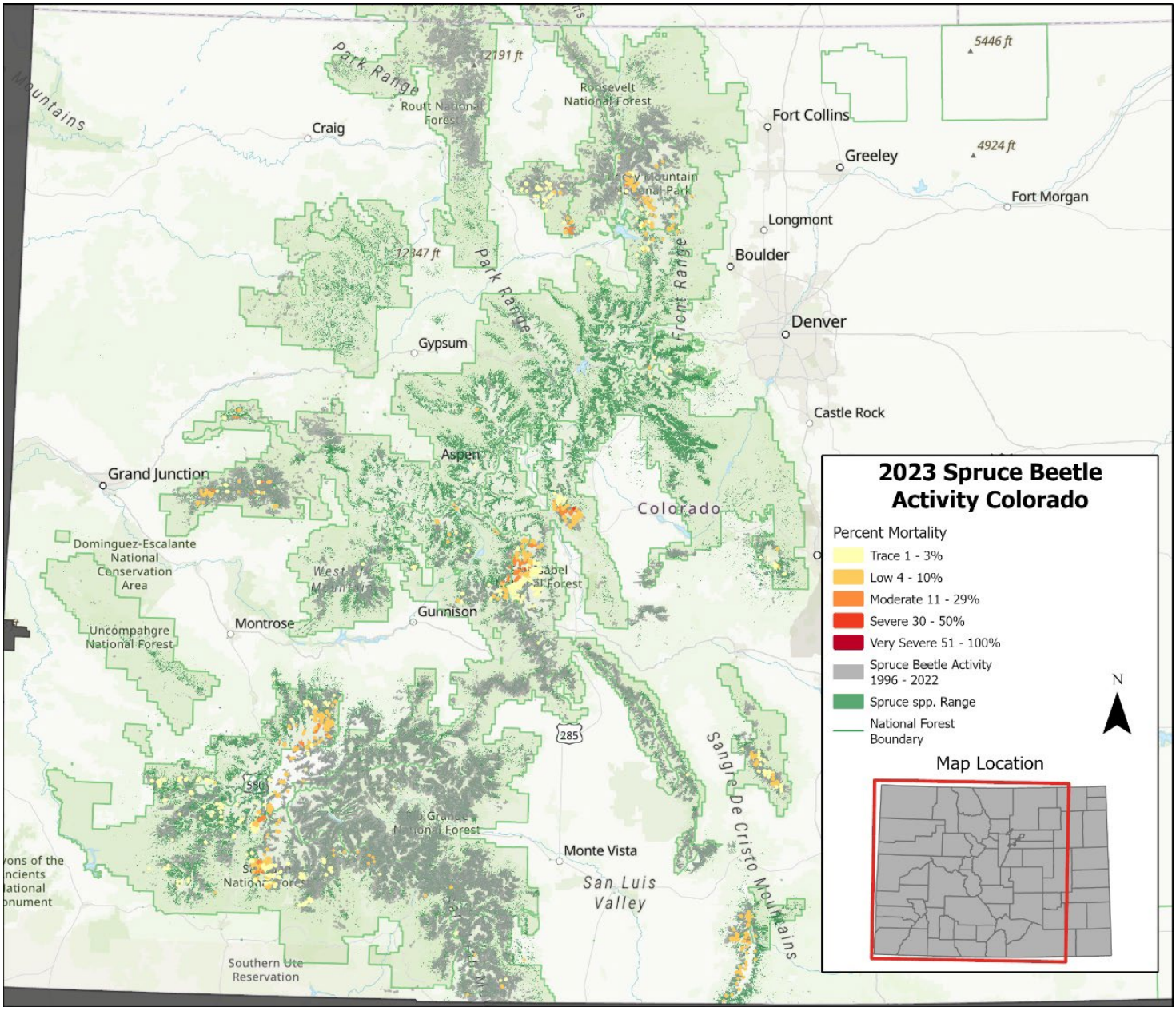

Figure 4. Spruce beetle-affected areas in Colorado vary in intensity as observed by the 2023 aerial detection survey. Spruce cover type is shown in green and previously mapped damage is in grey. Map by Nathan Edberg, USDA-FS.

Aerial surveys mapped spruce beetle-caused mortality on 2,800 acres in the R2 portion of Wyoming (Figure 5). Spruce beetle activity continues in the southern Shoshone National Forest, particularly outside of Dubois in the Union Pass area. The amount of spruce beetle activity continues to decline as the hosts are becoming depleted in this area.

The Crater Ridge fire on the Bighorn National Forest burned in the summer of 2021. In 2023 there was light and scattered spruce beetle activity in the fire area (Figure 3 and 6). Fire damaged trees have weakened defenses and, much like windthrown trees, can provide host material for spruce beetle populations to increase and spillover into nearby undamaged stands. Since spruce beetle has a two-year lifecycle, we expect that if this type

of spillover does occur in this instance, we will be able to begin to observe it in 2024. There also continues to be light and scattered single trees and small groups of spruce beetle activity in the Dayton Gulch area on the Medicine Wheel and Tongue Ranger Districts.

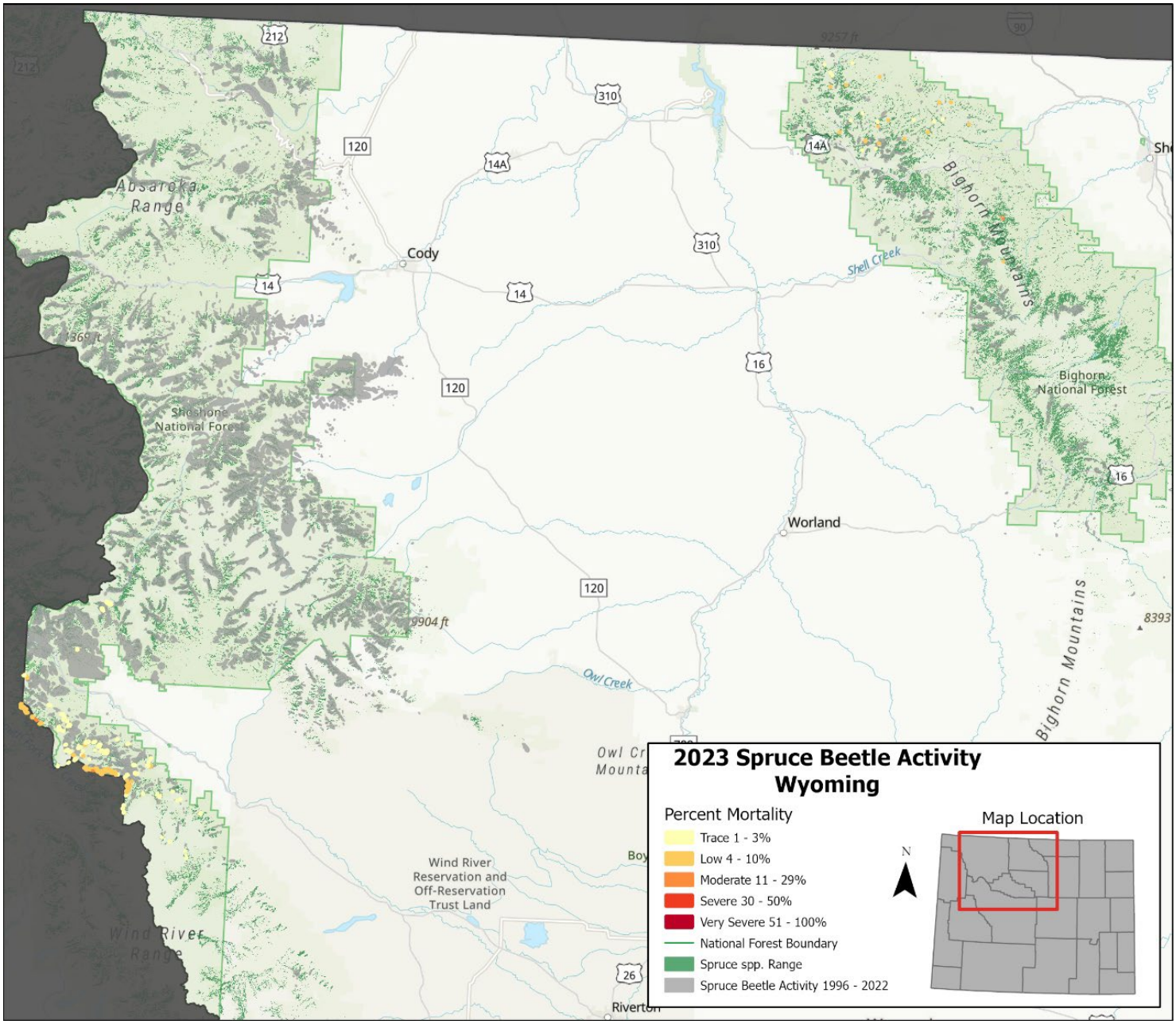

Figure 5. Spruce beetle-affected areas in Wyoming vary in intensity as observed from the 2023 aerial detection survey. Spruce cover type is shown in green and previously mapped damage areas are in grey. Map by Nathan Edberg USDA-FS.

Figure 6. Engelmann spruce trees attacked by spruce beetle, Bighorn National Forest. Photos by Kurt Allen and Kendra Schotzko, USDA-FS.

Mountain Pine Beetle

Dendroctonus ponderosae

Hosts: ponderosa, lodgepole, limber, whitebark and bristlecone pine

Region 2 has several areas of increasing mountain pine beetle activity, primarily in the upper Gunnison River drainages and near Idaho Springs in Clear Creek County. Aerial surveys conducted in 2023 identified heightened levels of mountain pine beetle activity in the front range foothill forests on and around the Pike National Forest (Figure 7).

Lakewood Service Center staff of FHP conducted walk-through inspections of various recreation areas on the Pike National Forests to examine the extent of mountain pine beetle activity in popular recreation areas. Fall surveys documented significant increased activity in all sites in 2023. High ratios of green, recently-attacked trees to red, dead trees caused by mountain pine beetle are a strong indicator of a growing beetle population. Many of these recently identified beetle-infested trees had green crowns and were unable to be detected by aerial survey this season. To expand on these surveys FHP personnel installed transects in areas outside of recreation sites to help gain a better understanding of current mountain pine beetle activity along the Front Range in ponderosa pine forests. Figure 8 illustrates the number of mountain pine beetle-infested trees observed in these transects.

Mountain pine beetle continues to expand on the Gunnison National Forest. Acres detected by aerial surveys have increased from 1,000 acres in 2022 to 1,400 acres in 2023 mostly in lodgepole pine, but also in limber pine. The ongoing mountain pine beetle outbreak that originated in and around the Wilder-Gunnison Highlands developments in the lower Taylor River basin continues to expand into the Fossil Ridge wilderness and Taylor Canyon. Mountain pine beetle activity also continues to expand in the West Elk Mountains, predominantly in the Ohio Creek drainage and Crested Butte areas (Figure 9). Pockets of mountain pine beetle activity persist in the Mosquito Range southeast of Leadville (Figure 10) and in Sangre de Cristo Mountains near Alamosa, affecting limber, ponderosa and Rocky Mountain bristlecone pines (Figure 10).

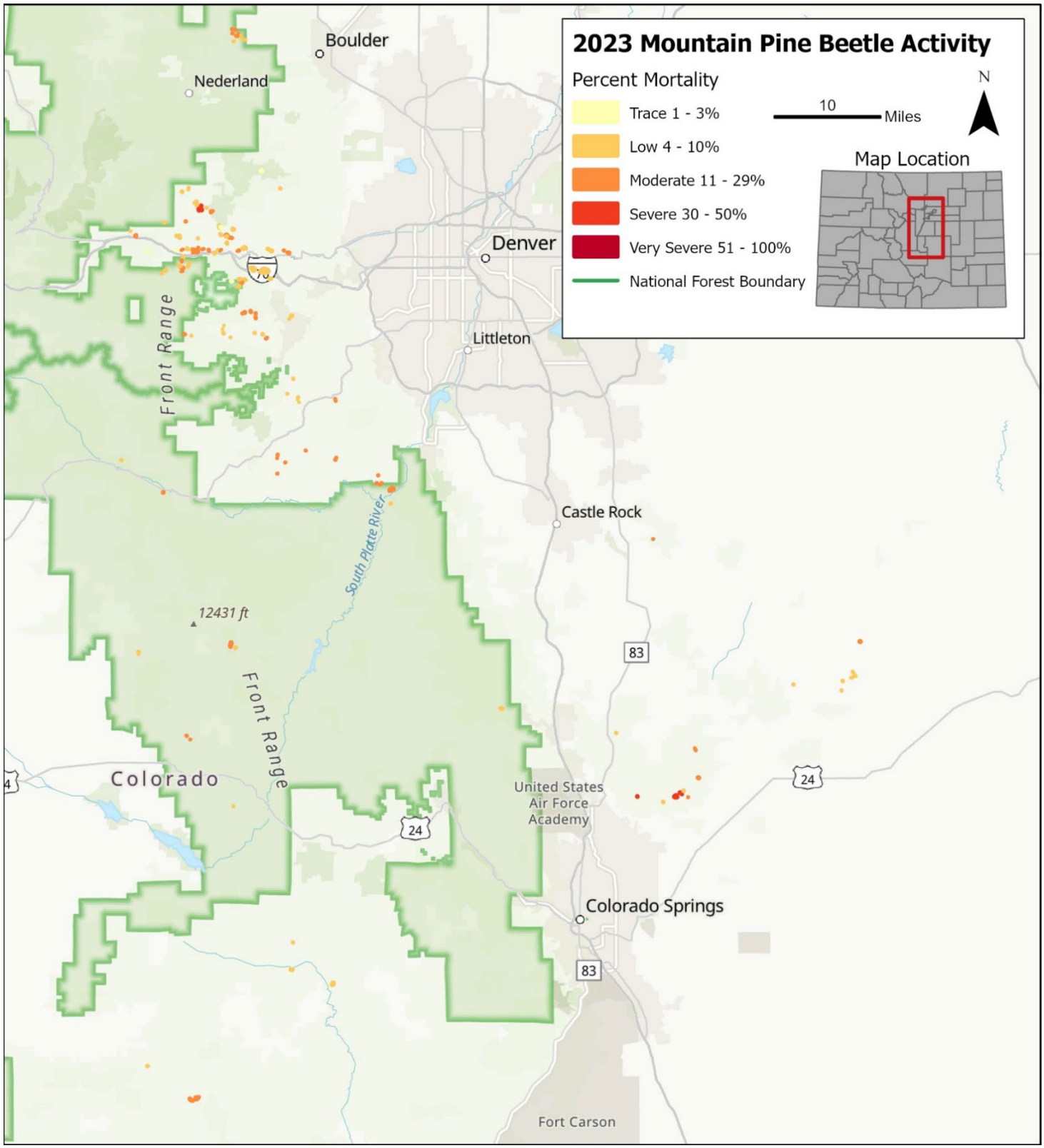

Figure 7. Mountain pine beetle activity in ponderosa pines as observed by the 2023 aerial survey in the front range foothills of Colorado. Map by Nathan Edberg, USDA-FS.

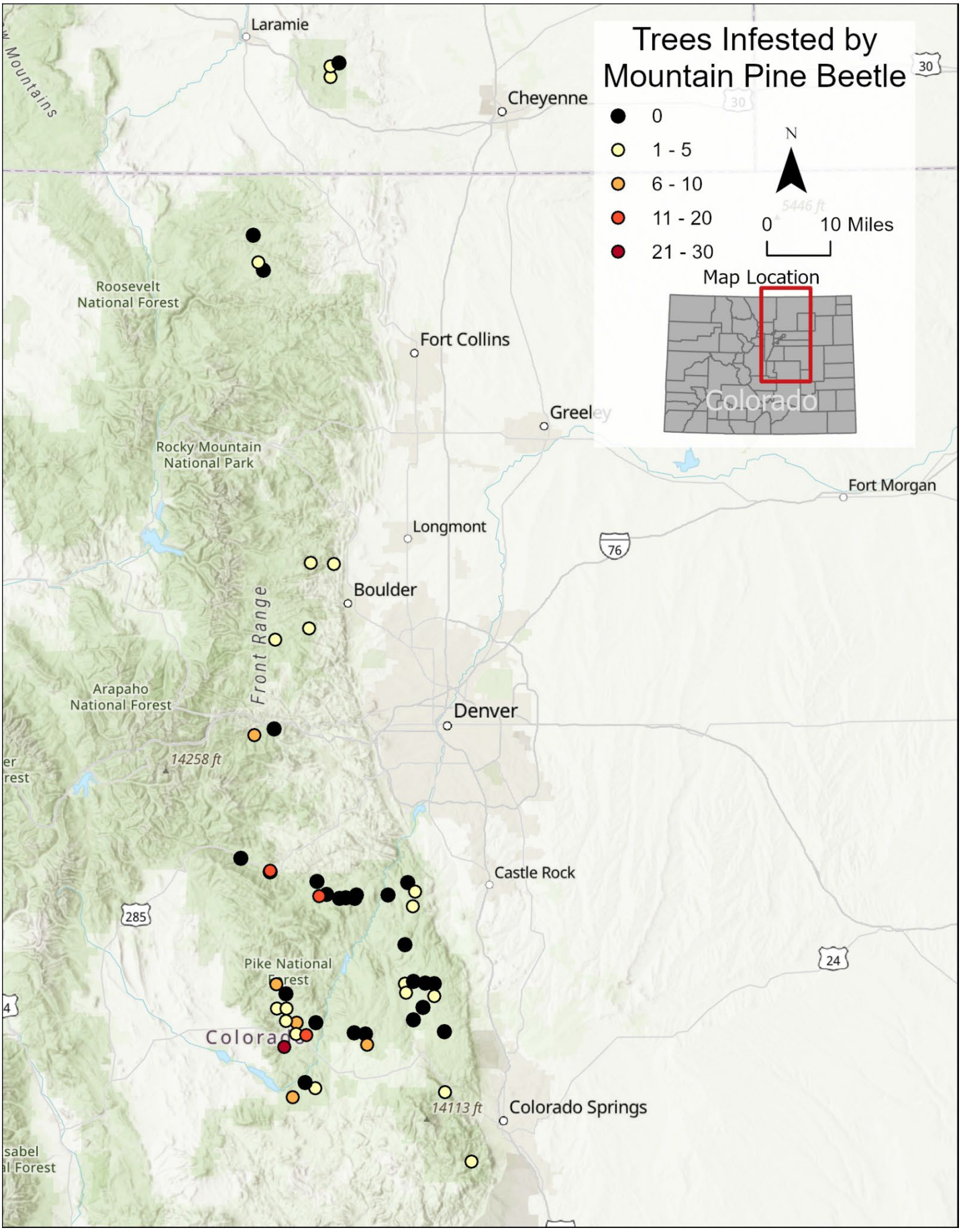

Figure 8. Number of infested mountain pine beetle infested ponderosa pine trees observed on ground transects installed in 2023 on the front range. Map by Nathan Edberg, USDA-FS.

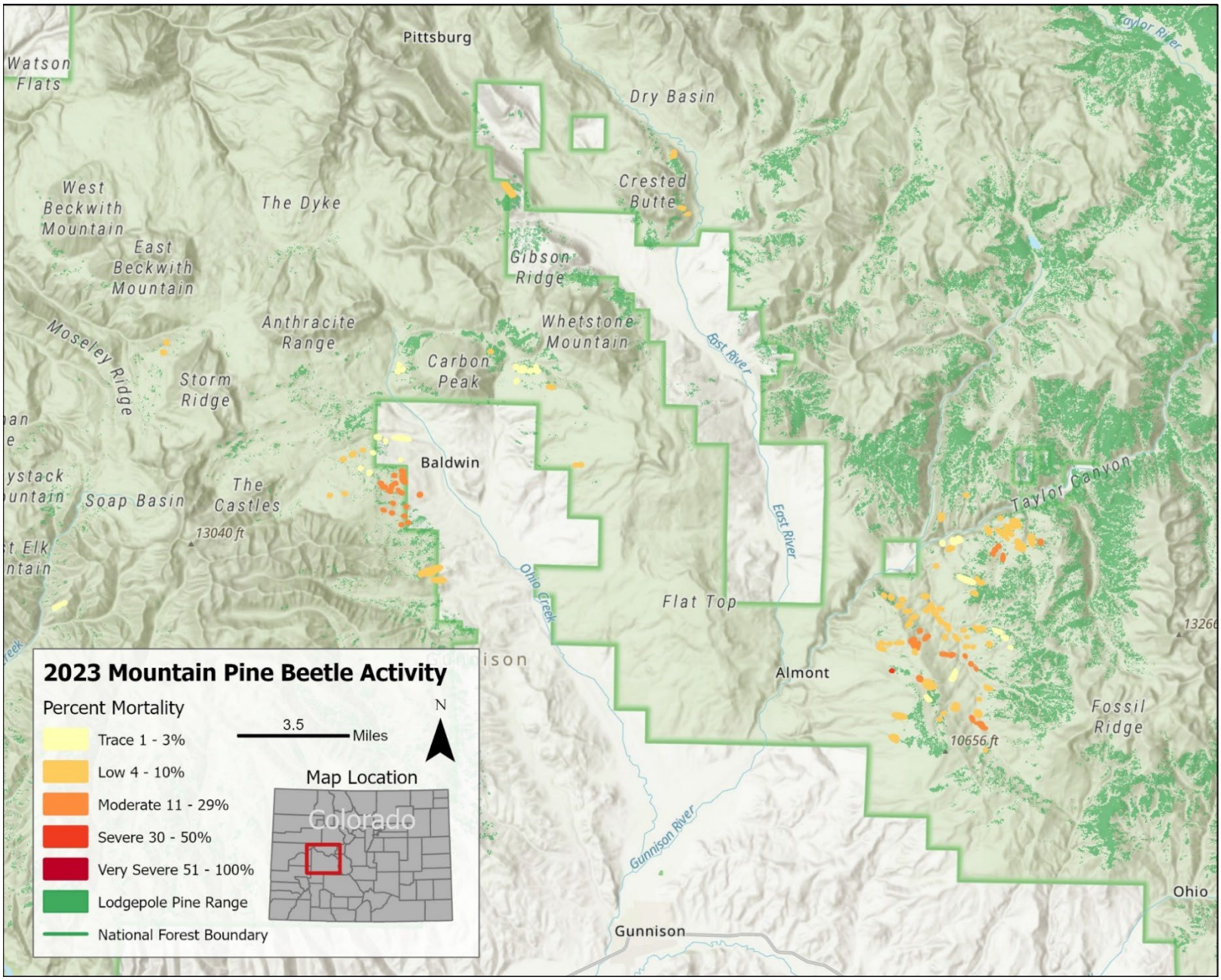

Figure 9. Mountain pine beetle activity in and around the Wilder-Gunnison Highland outbreak area in the lower Taylor basin, in the West Elk Mountains around Crested Butte and along Ohio Creek as observed from the 2023 aerial detection survey and nearby susceptible lodgepole pine forests. Map by Nathan Edberg, USDA-FS.

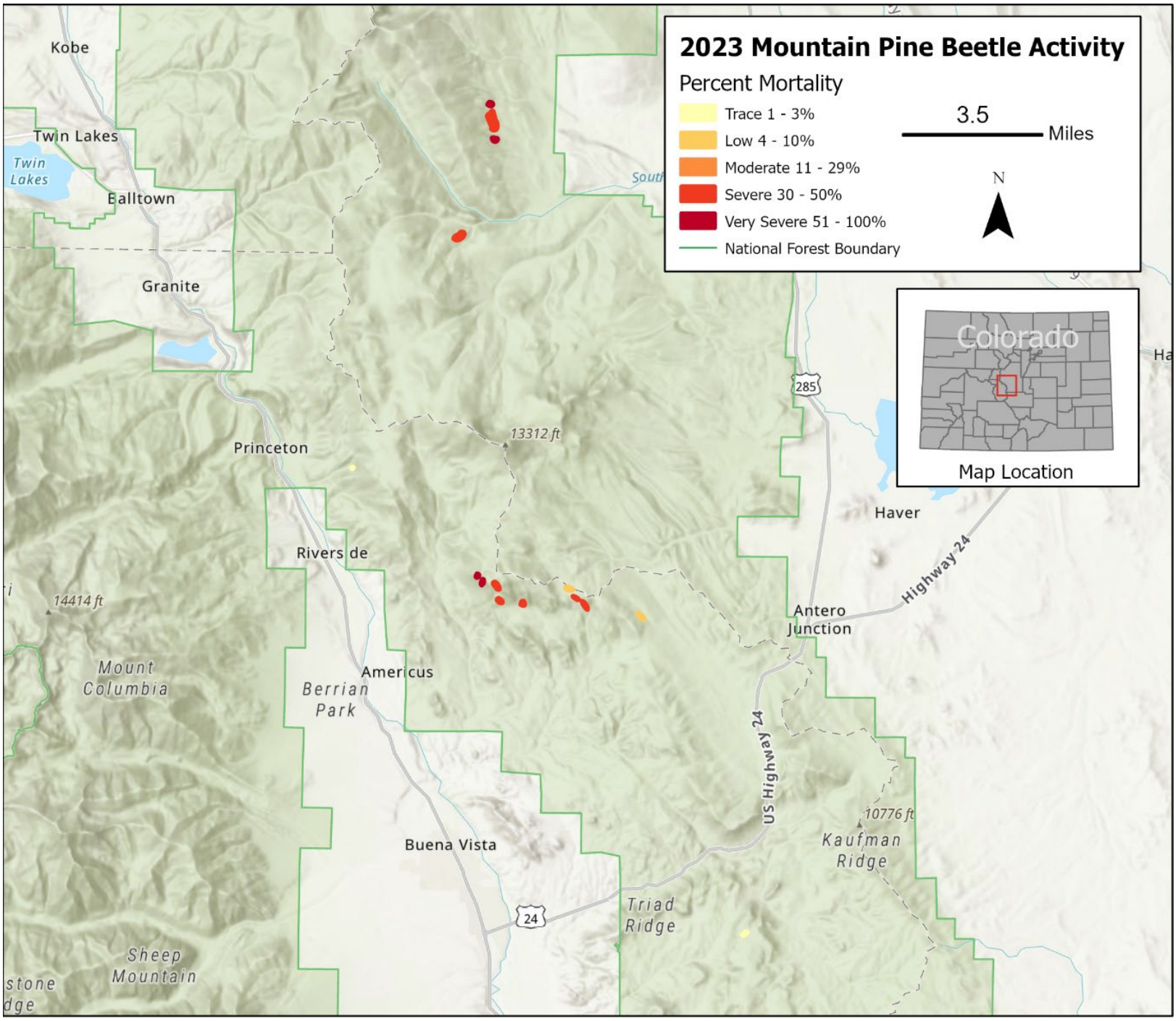

Figure 10. Mountain pine beetle primarily attacking ponderosa, limber and bristlecone pines on the northern San Isabel National Forest as observed by the 2023 aerial survey. Map by Nathan Edberg, USDA-FS.

In Wyoming, there was a small increase in mountain pine beetle activity in the ponderosa pine along the eastern edge of the Bighorn Mountains (Figure 11). Much of it was occurring on state, private and Bureau of Land Management (BLM) lands with some activity also observed on the Bighorn National Forest. There also appears to be a small uptick in mountain pine beetle activity in some of the limber pine stands on the Bighorn National Forest.

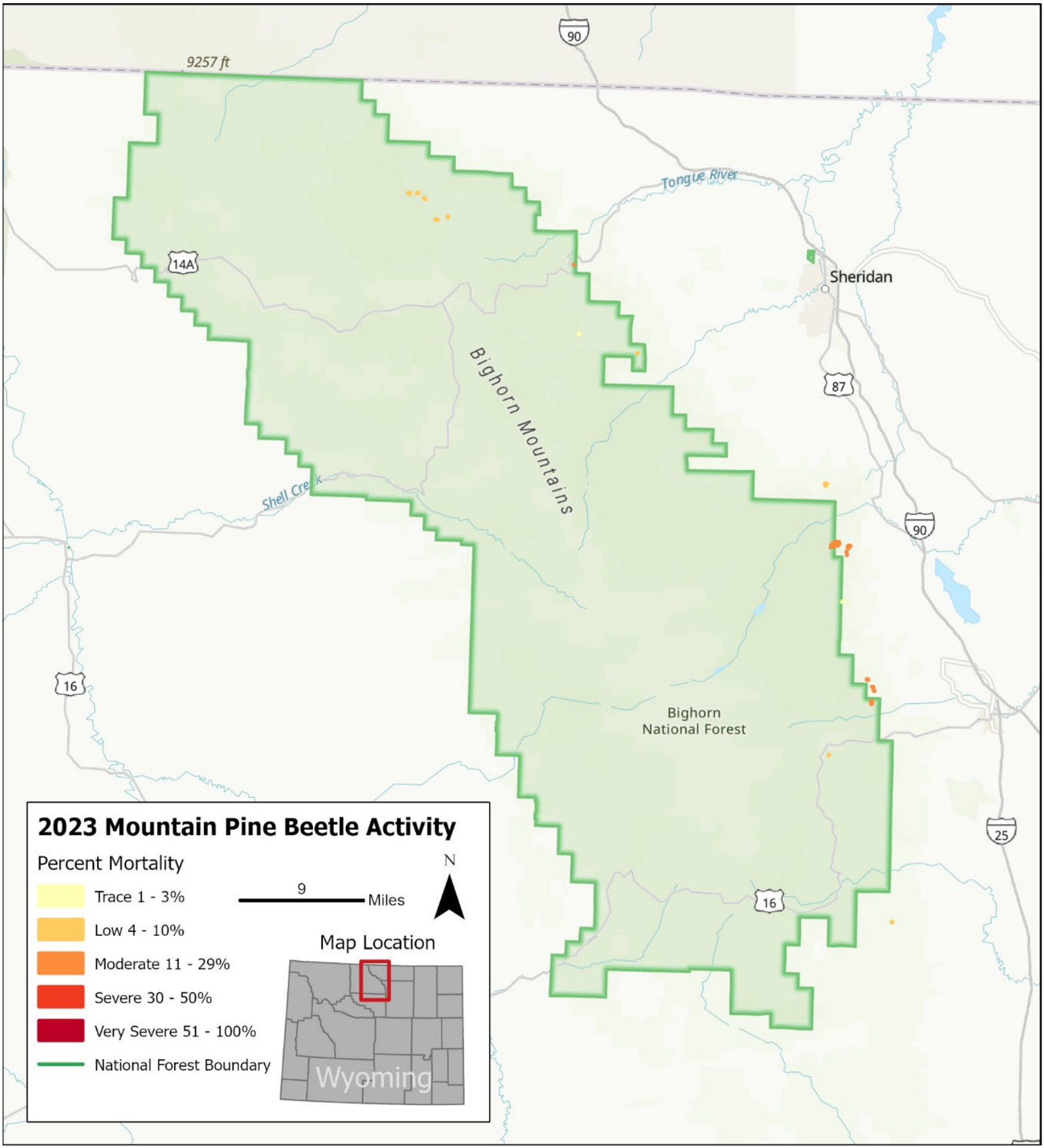

Figure 11. Mountain pine beetle primarily attacking ponderosa and limber pines on and adjacent to the Bighorn National Forest as observed by the 2023 aerial survey. Map by Nathan Edberg, USDA-FS.

Since the last epidemic in the Black Hills of South Dakota and Wyoming ended nine years ago, mountain pine beetle has been at very low (endemic) levels. Starting in 2022, an increasing trend in new mountain pine beetle killed trees has been observed. This activity is still light and scattered (Figure 12), but the presence of small groups of infested trees indicate activity is increasing. Activity is generally confined to larger trees in high density stands on steep rocky slopes that are inaccessible so have not been thinned (Figure 13). In other parts of the Black Hills National Forest, mountain pine beetle activity is very low, consisting of single trees attacked by mountain pine beetle with additional mortality being caused by pine engraver (*Ips*) beetles.

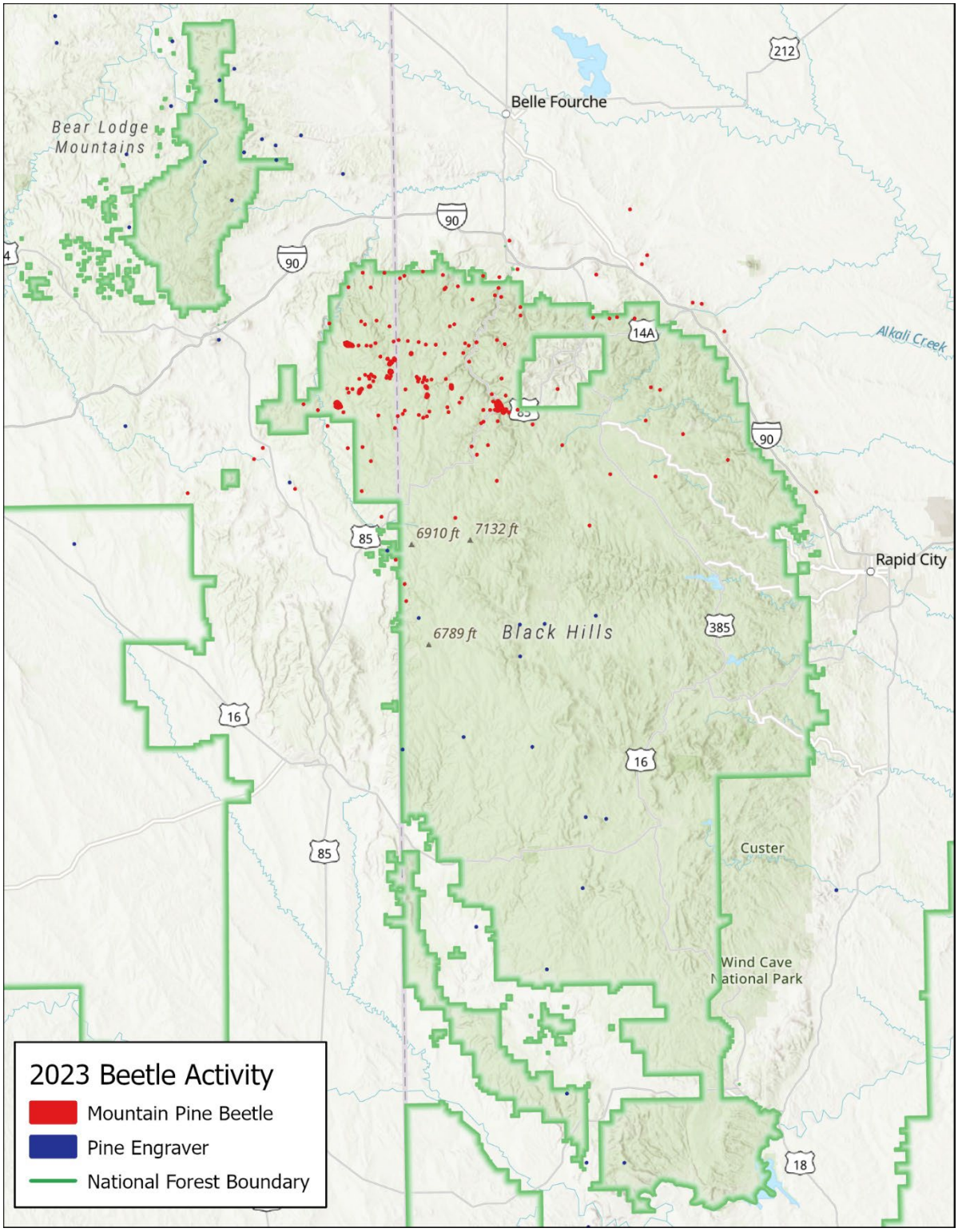

Figure 12. Mountain pine beetle in the northwest and pine engraver (*Ips*) beetle activity throughout the Black Hills National Forest as observed by the 2023 aerial survey. Map by Nathan Edberg, USDA-FS.

Figure 13. Mountain pine beetle infesting ponderosa pine in steep, inaccessible areas in the Northern Hills Ranger District, Black Hills National Forest. Photos by Kurt Allen and Kendra Schotzko, USDA-FS.

Roundheaded Pine Beetle Complex in Ponderosa Pine

Roundheaded pine beetle, *Dendroctonus adjunctus*
Southwestern pine beetle, *Dendroctonus barberi*
Mountain pine beetle, *Dendroctonus ponderosae*
Pine engraver or *Ips* bark beetles, *Ips* spp.

Host: ponderosa pine

"Roundheaded pine beetle complex" refers to an epidemic of several bark beetle species simultaneously causing mortality in ponderosa pine. The species included in this complex are primarily roundheaded pine beetle and southwestern pine beetle (previously identified as western pine beetle), as well as mountain pine beetle and pine engraver beetles. This epidemic is ongoing in portions of southwestern Colorado (Figure 14). Populations are spreading from the Glade, located on the Dolores Ranger District of the San Juan National Forest, where significant mortality of ponderosa pine associated with this complex was first observed by aerial surveys in 2013. The fact that roundheaded pine beetle has remained in outbreak for over a decade is unusual as our past experience with this beetle in areas to the south is that outbreaks have been shorter in duration, typically lasting no more than three years. Expansion from the Glade is continuing both north and eastward into ponderosa pine stands (Figure 15).

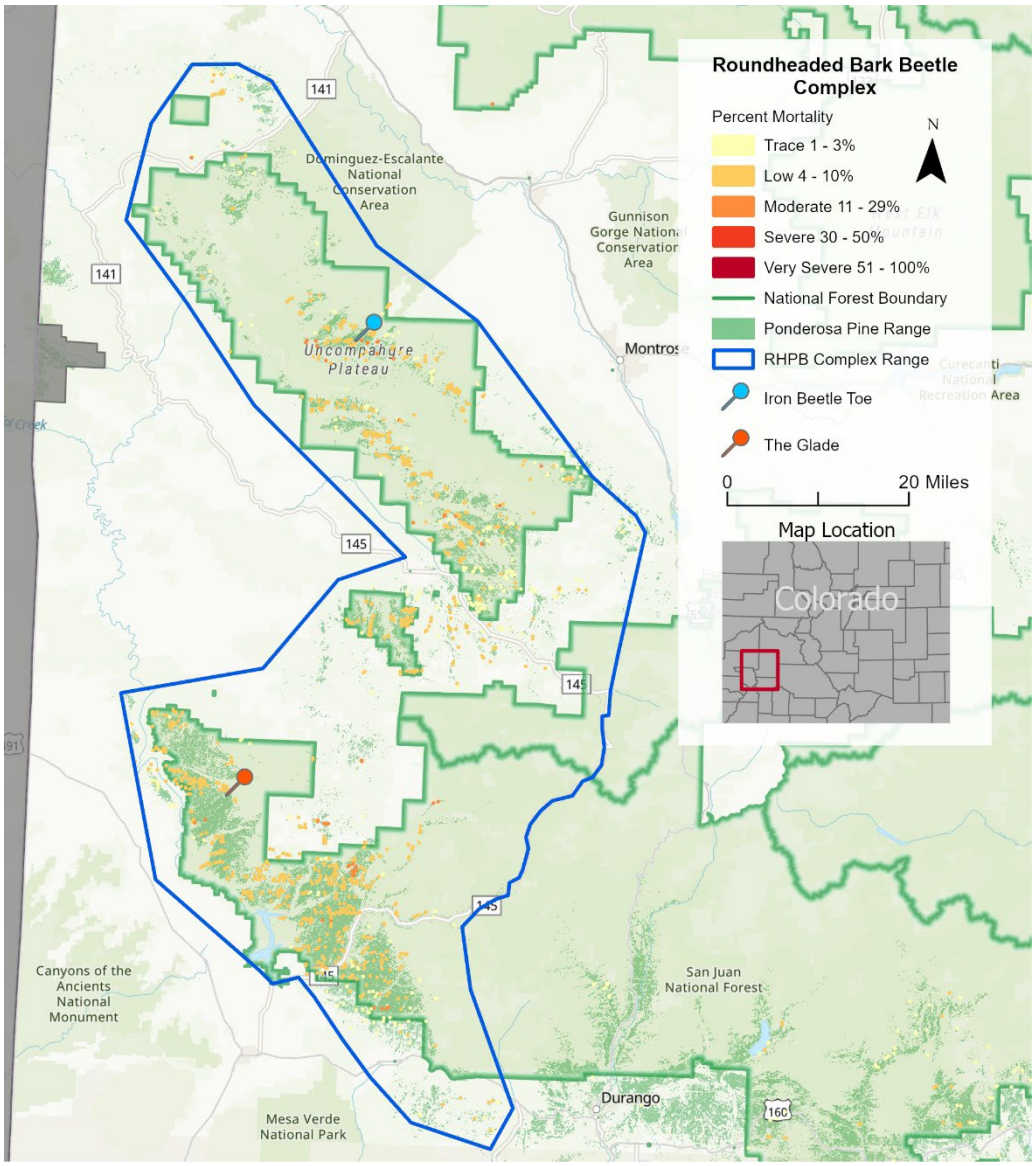

Figure 14. Roundheaded pine beetle complex activity as observed by the 2023 aerial survey. The blue boundary line delineates our current understanding of the extent of bark beetle-caused ponderosa pine mortality associated with this complex of beetles. Map by Nathan Edberg, USDA-FS.

Figure 15. Aerial view of roundheaded pine beetle complex activity spreading from the Glade on the Dolores Ranger District on the San Juan National Forest. Photo by Matthew Ethington USDA-FS.

Forest Health Protection has contributed funding to support removal or “sanitation” of infested trees and thinning efforts in the timber management area on San Juan and Uncompahgre National Forest lands shown in Figure 16. The roundheaded pine beetle complex has also spread further north, with increased activity in the Norwood and Ouray Ranger Districts of the Uncompahgre National Forest. Ground surveys have detected the roundheaded pine beetle complex as far north as Iron Springs on the Uncompahgre Plateau. The severely affected ‘Iron Beetle Toe’ area on the Ouray Ranger District underwent an extensive sanitation treatment this year. Trapping surveys conducted in 2023 indicate that roundheaded pine beetle and southwestern pine beetle are the primary species present in both the San Juan and Uncompahgre National Forests, although the proportion of beetle species varies between locations.

Figure 16. Thinning and sanitation of ponderosa pine stands is ongoing in areas affected by roundheaded pine beetle complex on the Uncompahgre National Forest, these efforts were financially supported by Forest Health Protection. Photo by Matthew Ethington USDA-FS.

Douglas-fir Beetle

Dendroctonus pseudotsugae
Host: Douglas-fir

Douglas-fir beetle activity is scattered and widespread in Wyoming and Colorado (Figure 17). Douglas-fir beetles preferentially attack large, old trees in dense, stressed stands. In recent years, drought conditions and years of heavy western spruce budworm defoliation has caused tree stress resulting in increased Douglas-fir beetle activity. Aerial surveys recorded Douglas-fir beetle activity on 17,000 acres in Colorado alone, with an additional 350 acres in Wyoming.

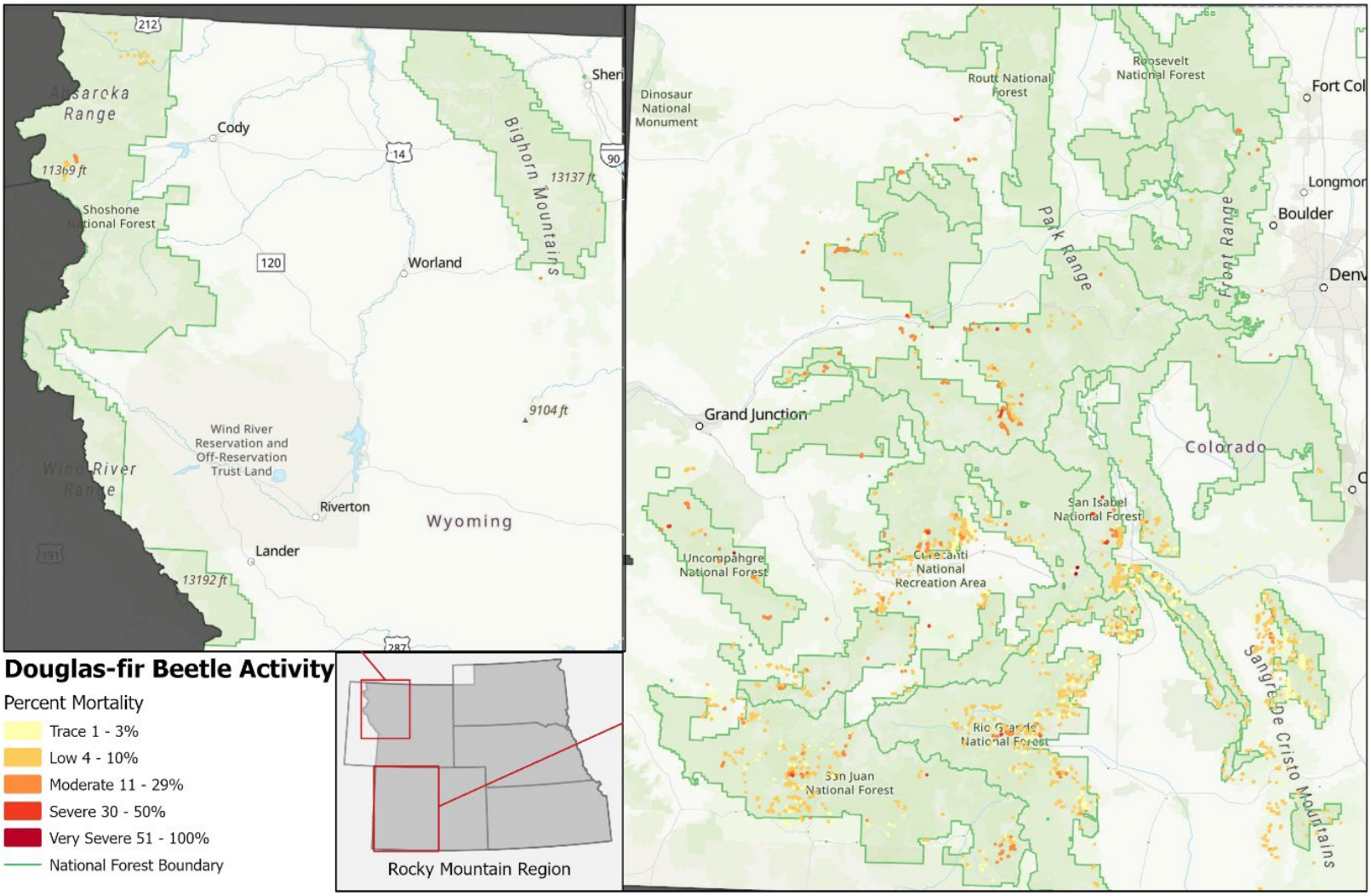

Figure 17. Douglas-fir beetle-caused tree mortality as observed from the 2023 aerial detection survey in Wyoming and Colorado is often associated with stress caused by previous years' drought and western spruce budworm defoliation. Map by Nathan Edberg, USDA-FS

In Wyoming, defoliation caused by western spruce budworm in the Clarks Fork area on the northern Shoshone National Forest (Clarks Fork Ranger District) has been extensive (Figure 18) and the Douglas-fir beetle acreage is likely higher than indicated by aerial surveyors. This is because the lack of foliage caused by severe defoliation can prevent aerial surveyors from identifying Douglas-fir infested by Douglas-fir beetle. Ground observations indicate Douglas-fir beetle activity has increased significantly in Sunlight Basin (Clarks Fork Ranger District), with widespread attacks on trees that had been compromised by western spruce budworm defoliation. Ground observations indicate that Douglas-fir beetles are moving into less damaged green trees at this time. Additionally, there has been light and scattered Douglas-fir beetle activity along the North Fork of the Shoshone River (Wapiti Ranger District), which appears to have been started in trees that were stressed due to fire damage in the surrounding area.

Figure 18. Douglas-fir mortality caused by Douglas-fir beetle. Photos by Kurt Allen and Kendra Schotzko, USDA-FS.

In southwest Colorado, there was a significant increase in Douglas-fir mortality due to the combination of defoliation by western spruce budworm and attack by Douglas-fir beetle. For example, in Gunnison county aerial surveys documented an increase from 460 acres in 2022 to 3,000 acres in 2023, and in Saguache County, there was an increase from 1,100 acres in 2022 to 2,900 acres in 2023. Aerial observations on the Grand Mesa, Uncompahgre and Gunnison National Forests indicate that trees located in drainages at lower elevations are most affected. The San Isabel National Forest also experienced substantial Douglas-fir beetle caused mortality both in the Wet and Sangre De Cristo Mountains.

Fir Engraver

Scolytus ventralis

Host: white fir

Fir engraver has been causing mortality and top kill of large mature white fir trees in southern Colorado for many years. In 2023, aerial surveys detected 4,100 impacted acres, slightly down from 4,600 acres in 2022 (Figure 19). High levels of fir engraver activity continue to be observed in and around the town of Ouray, where fir engraver has been active for several years. Impacts on individual trees include mortality and top-kill which occurs when fir engraver beetles infest the upper portions of the tree's bole, girdling the tree in the area of attack which kills the upper crown and leaves the lower crown unharmed. In the last several years, fir engraver activity has been observed north of Durango, on Hwy 550 in the vicinity of the 416 Fire, which burned in 2018 (Figure 20). Trees that survived the burn have been subjected to increased insect activity due to environmental stressors. The Amphitheater Campground in the Ouray Ranger District on the Uncompahgre National Forest and vicinity has experienced a huge hit by fir engravers (Figure 21), the campground alone has removed over 1,000 white fir in the last decade. This outbreak has been compounded by annosus root disease which is also being treated by the Ranger District after harvesting white fir. Forest management activities have been favoring more resilient tree species through planting pines and protecting existing Douglas-fir trees from Douglas-fir beetle by deploying the anti-aggregation pheromone MCH in high-value stands.

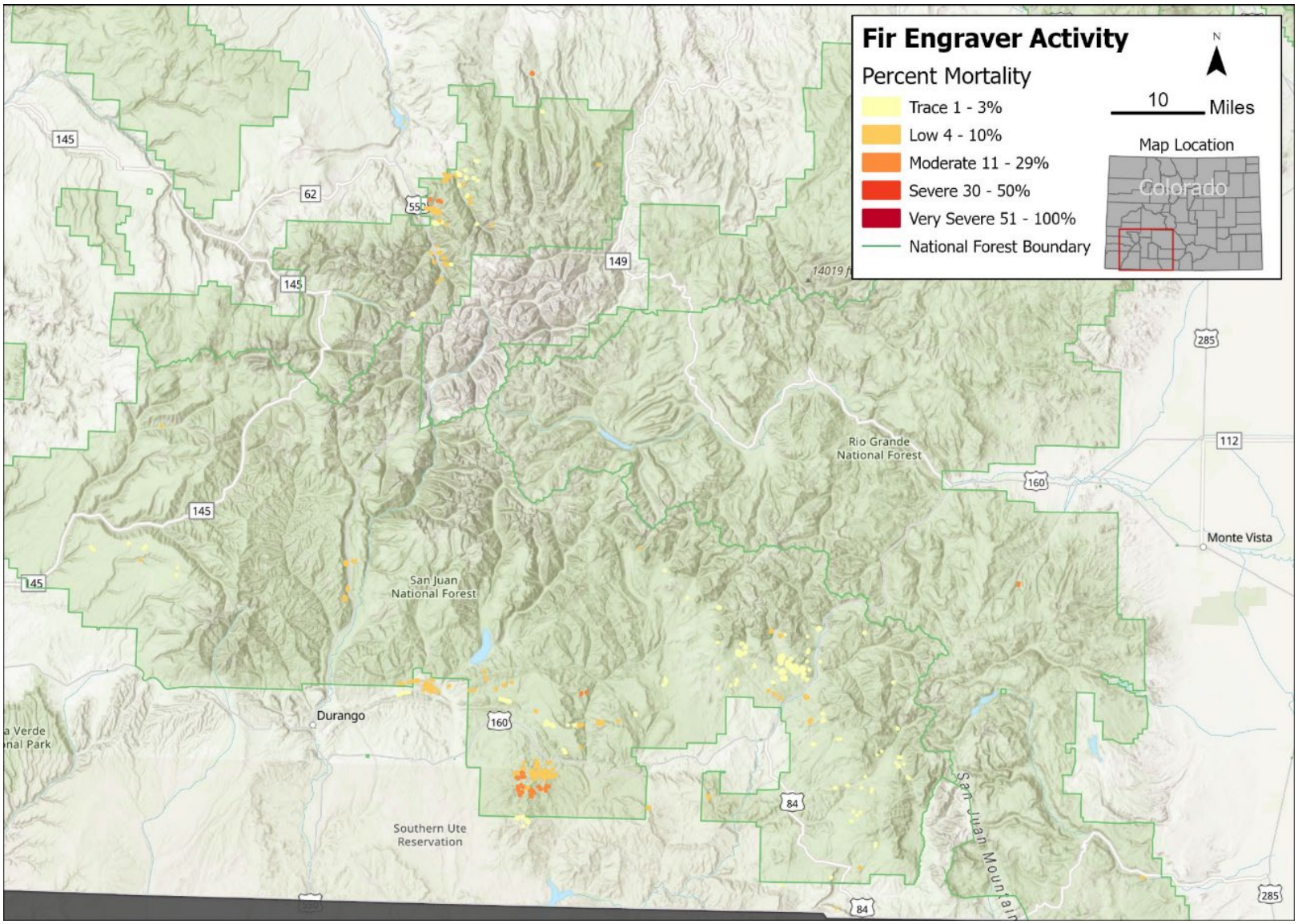

Figure 19. Fir engraver-caused mortality of white fir in and around the San Juan and Rio Grande National Forests as observed by the 2023 aerial surveys. Map by Nathan Edberg, USDA-FS.

Figure 20. White fir dying from fir engraver west of Haviland Lake, Durango, CO, exacerbated by the 416 fire. Photo by Amy Lockner, USDA-FS.

Figure 21. White fir mortality caused by fir engraver in Ouray, CO. The Amphitheater Campground is hidden at the base of the mountains. Photo by Amy Lockner, USDA-FS.

Engraver Beetles and Twig Beetles in Pines

Ips spp., *Pityophthorus* spp. and others

Hosts: ponderosa, lodgepole, limber and pinyon pine

Engraver (*Ips*) beetles typically cause mortality in host trees that are stressed, most often due to drought. This is especially prevalent in lowland-woodland forests. Most species of these beetles can have multiple generations in a single year so outbreaks can grow in size substantially over relatively short time periods when conditions are favorable.

In Colorado, over the past five years, persistent drought had created favorable conditions for increased engraver activity in pine species, however the wet 2022-23 winter and spring resulted in significant reductions in the activity of some of these beetles. For example, aerial surveys detected 1,200 acres of pine affected by pinyon ips in 2023, a decrease of nearly 74%. Pinyon ips beetle populations remain persistent on the lower elevations of the Uncompahgre plateau (Figure 22). The pinyon ips populations around Ridgeway and Naturita remain persistent with sporadic mortality occurring in these areas.

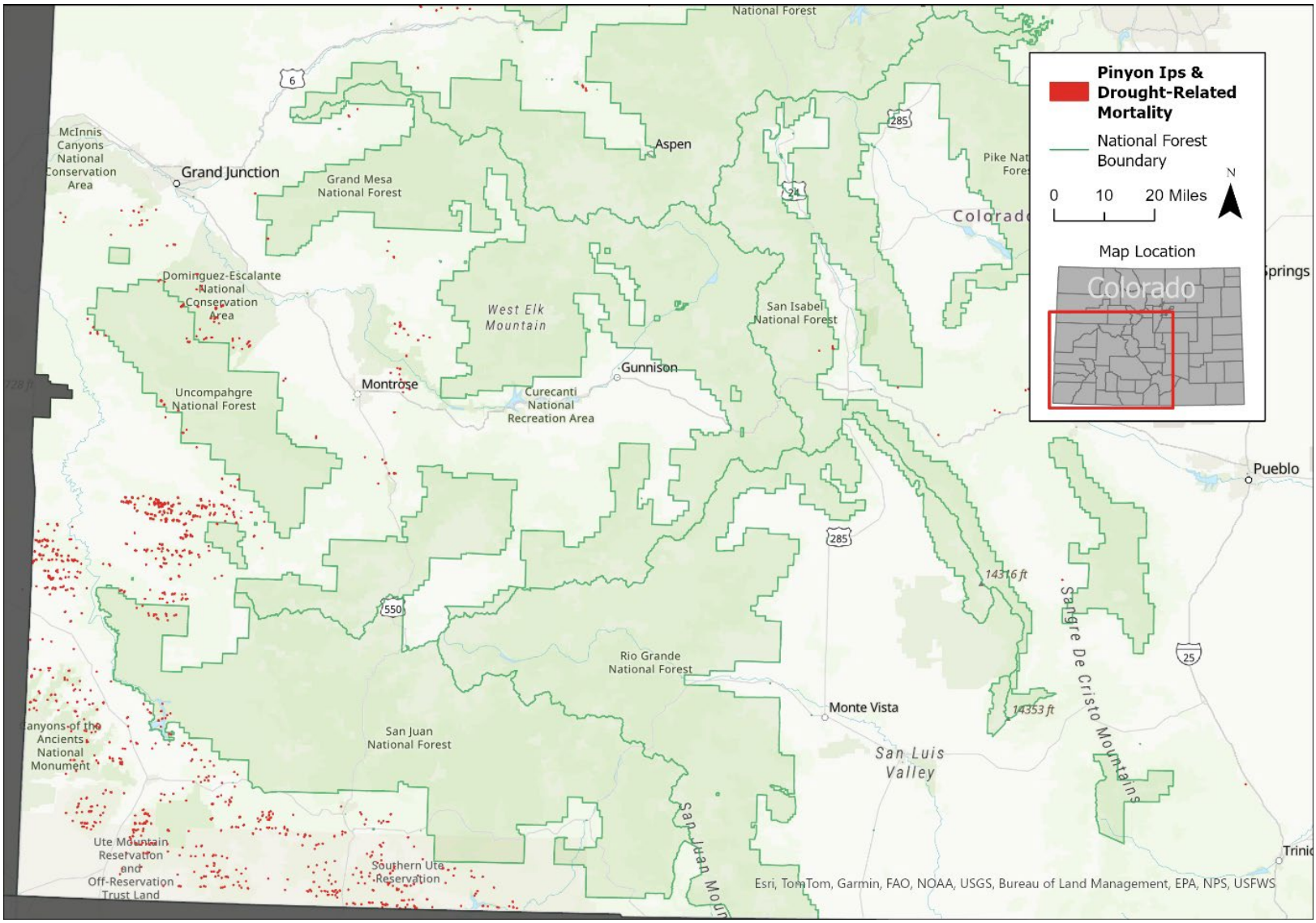

Figure 22. Pinyon *Ips* and drought-related juniper mortality observed by the 2023 aerial surveys in southwest Colorado. Map by Nathan Edberg, USDA-FS.

In South Dakota and Nebraska, pine engraver beetles include a complex of multiple *Ips* species. In the Black Hills National Forest, pine engraver beetle activity appeared to decrease across the forest compared to the past 2-3 years. The one exception is in the southern Black Hills in areas that were heavily defoliated by pine looper in 2022 (Figure 40). In these areas, doghair clumps of small diameter ponderosa pine that have been stressed both by their high density and by the defoliation caused by the looper are experiencing pine engraver beetle activity.

In Nebraska there was a big increase in *Ips* activity on the Nebraska National Forest (Figure 23). Particularly noteworthy was the increase in tree mortality occurring in the McKelvie Unit observed by ground surveys. There was significant damage to the forested plantations in Halsey from wildfires, where large areas of the forest were killed or damaged. There was a high rate of woodborer infestation in damaged trees, and there is also concern of *Ips* increasing in these fire damaged areas. Pine engraver beetle activity over the Pine Ridge area was mostly limited to single trees, although some small groups could be found.

Figure 23. Fire damaged trees near Halsey (top row), and *Ips* beetle adults, larvae and galleries (bottom row), Nebraska National Forest 2023. Photos by Kurt Allen and Kendra Schotzko, USDA-FS.

Ips knausi, was collected from an attacked ponderosa pine tree North of Durango, Colorado near the 416 fire scar in October 2023 (Figure 24). This pest may be increasing its presence in Southwestern Colorado.

Figure 24. Knausi ips adults present in galleries on the underside of bark removed from an infested ponderosa pine on the San Juan National Forest. Photo by John Nelson, USDA-FS.

Twig Beetle in Fir

Pityophthorus sp.

Hosts: Subalpine fir

Twig beetle remains active in subalpine fir in the West Elk Range of Colorado on the Gunnison and Paonia Ranger Districts. This small beetle typically infests twigs and branches of live trees. Damage resulting from the construction of galleries kills branch tips which present an orangish-red color (Figure 25). Damage is typically scattered and doesn't appear to kill trees. The biology of this native pest is poorly understood.

Figure 25. Typical twig beetle damage on subalpine fir branches in the West Elk Mountains. Photo by John Nelson, USDA-FS.

Western Balsam Bark Beetle

Dryocoetes confusus

Host: subalpine fir

Western balsam bark beetle causes chronic, low-level mortality in the subalpine fir trees typically found at high elevations throughout the Rocky Mountain region. This beetle's activity tends to increase during periods of drought-caused tree stress and can cause alarming levels of mortality when conditions are favorable for the beetle. In Colorado, aerial surveys mapped 27,000 acres of pockets of mortality caused by western balsam bark beetle (WBBB) in subalpine fir in 2023 (Figure 26). In SW Colorado, mortality continued to be observed on the Grand Mesa, Uncompahgre, Gunnison (combined total of 5,600 acres) and San Juan National Forests (990 acres).

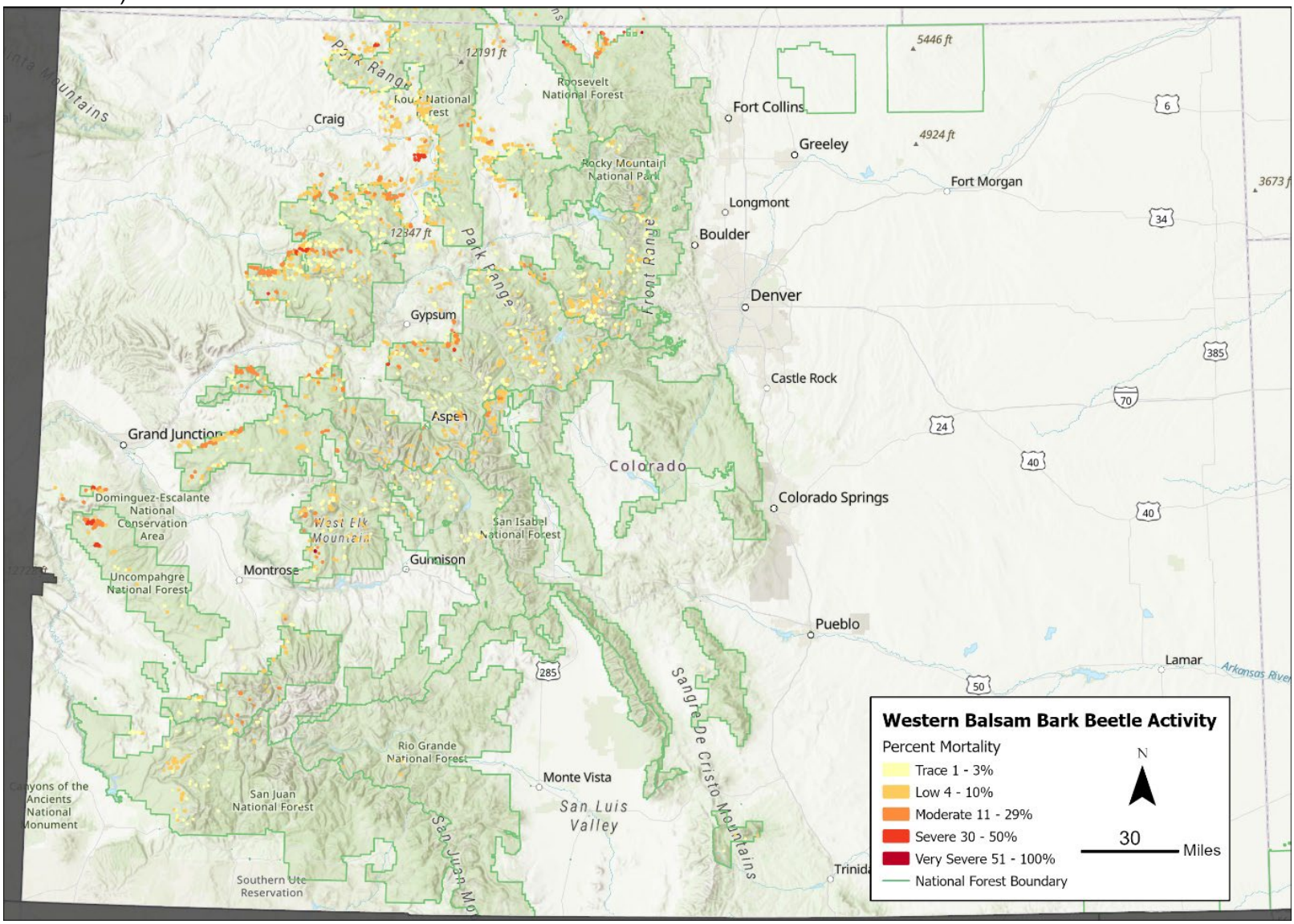

Figure 26. Trace to low-intensity western balsam bark beetle activity in subalpine fir in Colorado as observed from the 2023 aerial detection surveys. Map by Nathan Edberg, USDA-FS.

In Wyoming, aerial surveys indicated that subalpine fir mortality caused by western balsam bark beetle was light and scattered in the Absaroka, Wind River, Bighorn and Snowy Ranges (Figure 27). Ground surveys suggest a potential increase in western balsam bark beetle activity in the northern Bighorn Mountains.

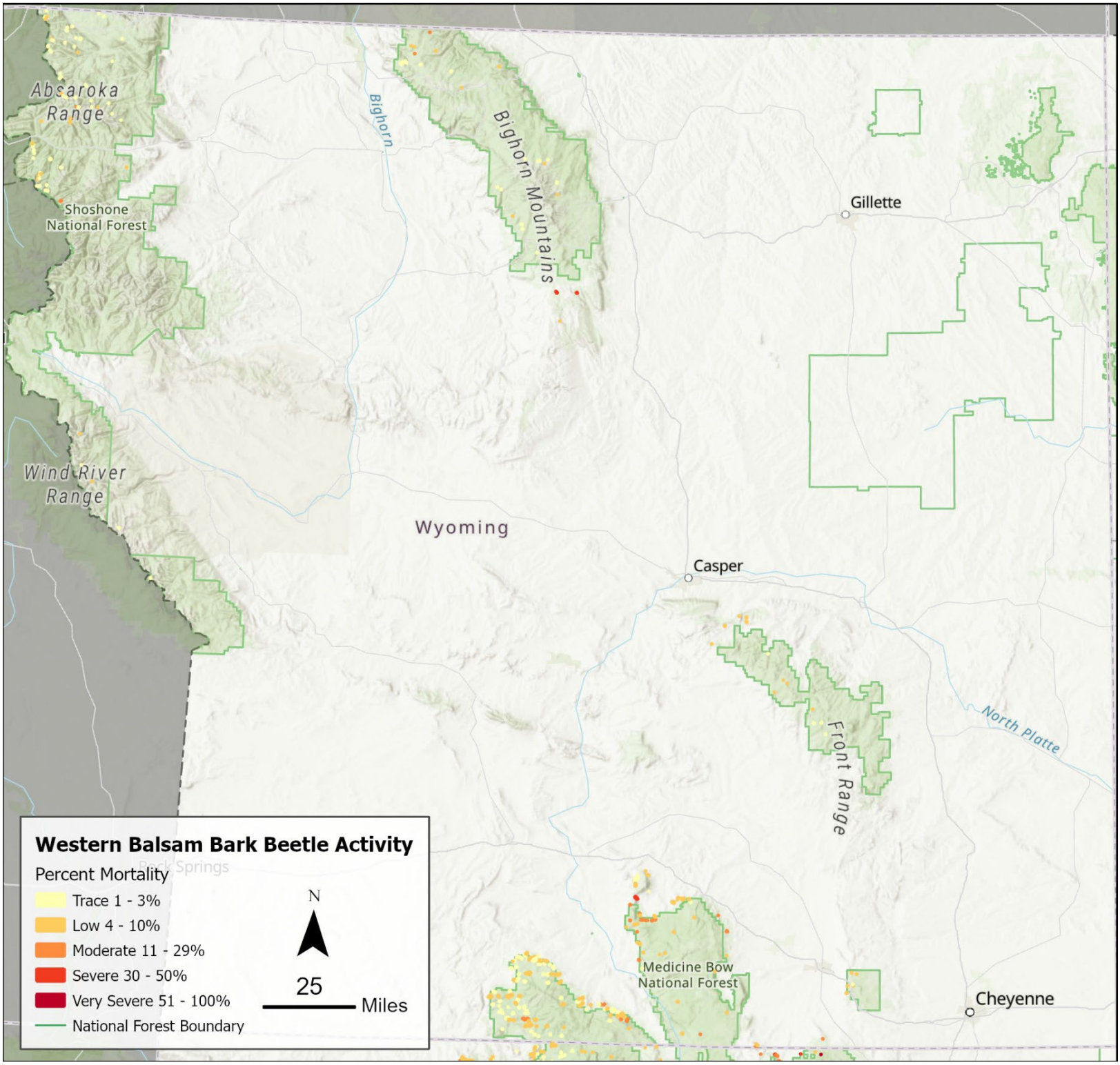

Figure 27. Trace to low-intensity western balsam bark beetle activity in subalpine fir in Wyoming as observed from the 2023 aerial detection surveys. Map by Nathan Edberg, USDA-FS.

Lodgepole Pine Beetle

Dendroctonus murrayanae

Host: lodgepole pine

Lodgepole pine beetle continues to be associated with limited/scattered mortality of lodgepole pine in the Bighorn National Forest (Figure 28). This is a relatively uncommon beetle in Region 2 and is not considered an insect of concern. Lodgepole pine beetle has been observed attacking single trees and small pockets of trees in the Bighorn National Forest. Infested trees often have preexisting stem damage. Identification was confirmed by USDA-FS FHP National Entomologist, Bob Rabaglia in 2021.

Figure 28. Lodgepole pine attacked by lodgepole pine beetle (left and center) and an adult lodgepole pine beetle and larvae (right), Bighorn National Forest. Photos by Kendra Schotzko, USDA-FS.

Status of Major Defoliators

Pine looper larva feeding on Ponderosa pine.
Photo by Brian Howell, USDA-FS

Status of Major Defoliators

Western Spruce Budworm

Choristoneura occidentalis

Hosts: true firs, Douglas-fir and spruce

Aerial surveys detected 202,000 acres of western spruce budworm activity in Colorado and 18,000 acres in Wyoming in 2023 (Figs. 29, 30). The western spruce budworm (WSB) remains a serious defoliator in Douglas-fir and mixed conifer forests throughout the region. There was a significant increase in WSB activity in high elevation spruce-fir forests.

An additional 90,000 acres of WSB was mapped in Colorado in 2023, nearly double the amount mapped in 2022. The Grand Mesa-Uncompahgre-Gunnison (GMUG), San Juan and White River National Forests were most affected. Delta, Garfield, Mesa and Pitkin counties experienced drastic increases in WSB activity, eleven times greater than levels observed in 2023. Ground observations in the Routt, Pike, Roosevelt, San Juan and GMUG National Forests recorded persistent heavy budworm damage and tree death in spruce-fir stands.

In Wyoming, western spruce budworm defoliation continues to occur across Douglas-fir stands on the Shoshone, Bighorn and to a lesser degree the Medicine Bow National Forests. In many of these areas, multiple years of heavy defoliation of Douglas-fir have resulted in unhealthy, stressed trees and tree mortality.

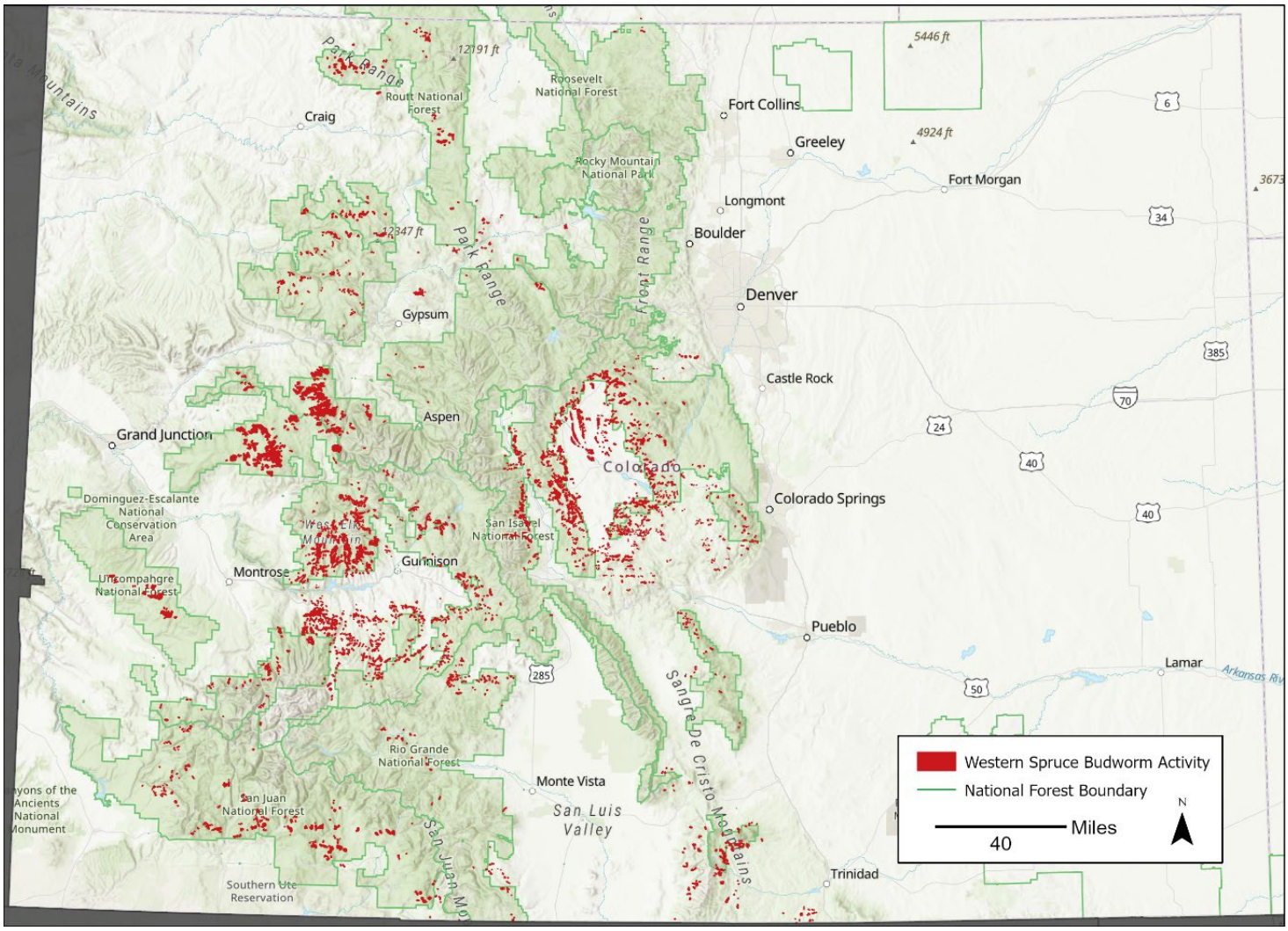

Figure 29. Western spruce budworm activity in Colorado as observed from the 2023 aerial detection survey. Map by Nathan Edberg, USDA-FS.

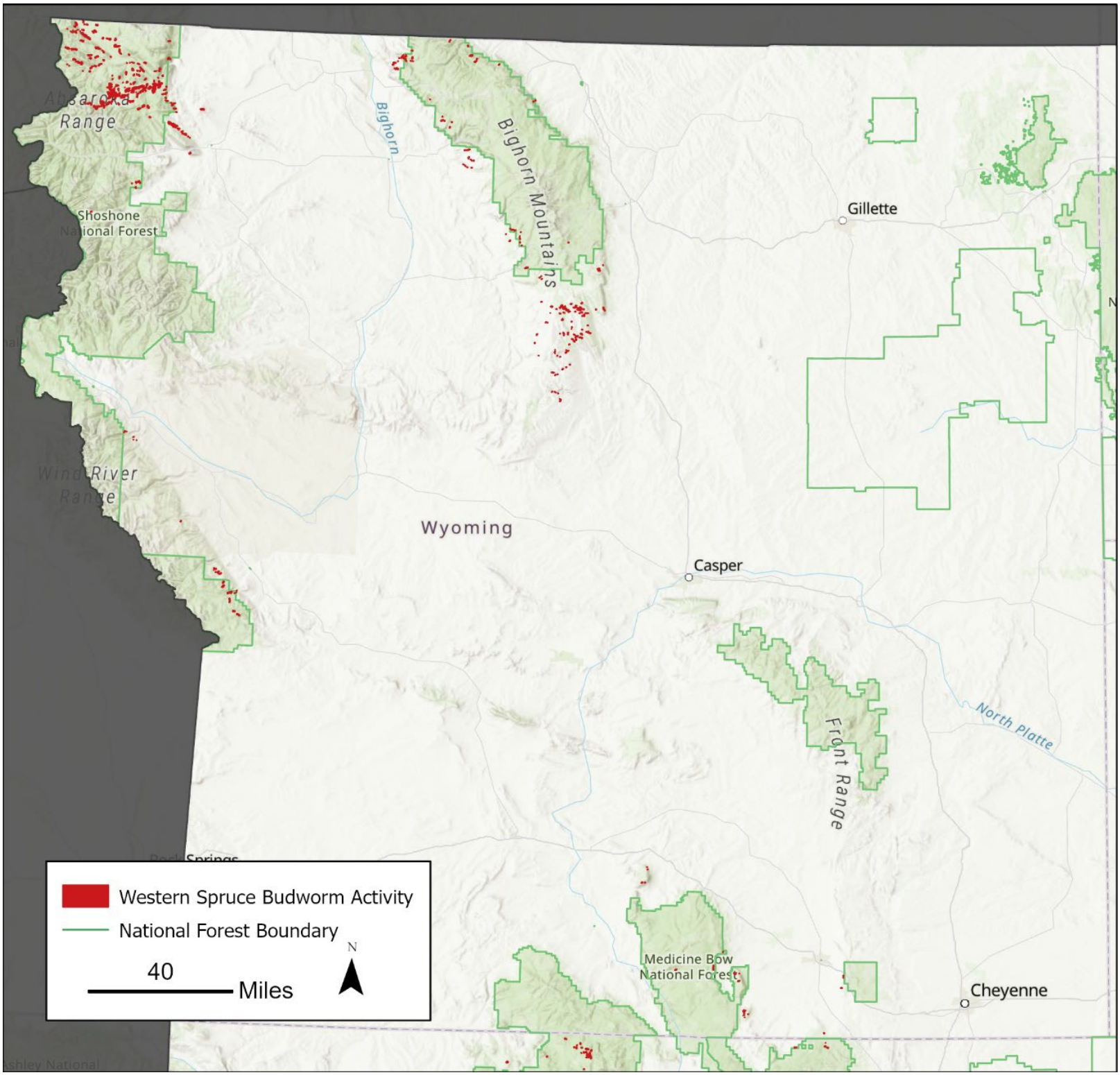

Figure 30. Western spruce budworm activity in Wyoming as observed from the 2023 aerial detection survey. Map by Nathan Edberg, USDA-FS.

As of 2023, defoliation of Douglas-fir stands in the northern Shoshone National Forest has declined significantly from its peak a few years ago. Many of these areas, however, are being impacted by Douglas-fir beetle as beetles take advantage of weakened trees. The most active defoliation on the northern Shoshone National Forest is now occurring in Engelmann spruce and subalpine fir stands at the northern end, with remnant areas of light defoliation on Douglas-fir occuring along Sunlight Road (Figure 31). In the southern Shoshone National Forest, defoliation of Douglas-fir has declined but continues at lower levels (Figure 32).

Figure 31. Douglas-fir, Engelmann spruce and subalpine fir trees defoliated by western spruce budworm in the northern Shoshone National Forest. Photos by Kendra Schotzko and Kurt Allen, USDA-FS.

Figure 32. Western spruce budworm moth (left) and feeding damage with empty budworm pupal case (right) observed on Douglas-fir at the south end of the Shoshone National Forest. Photos by Kendra Schotzko, USDA-FS.

In the Bighorn National Forest, western spruce budworm activity caused light defoliation in the Tensleep Canyon and Battle Park areas (Figure 33). Extremely light defoliation was also noted on Douglas-fir in the northern end of the Bighorn National Forest.

Figure 33. Western spruce budworm and associated feeding damage on Douglas-fir, Bighorn National Forest. Photos by Kurt Allen and Kendra Schotzko, USDA-FS.

Douglas-fir Tussock Moth
Orgyia pseudotsugata

Hosts: Douglas-fir, true firs and spruce

Douglas-fir tussock moth (DFTM) is a native defoliator in the western United States and Canada that impacts Douglas-fir, true firs and spruce in the Rocky Mountain Region. DFTM can be one of the most damaging western defoliators. Host damage is caused as larvae feed on the current year's foliage causing it to shrivel and turn brown. As larvae mature, they consume older, whole needles. Defoliation occurs first at the tops of trees and outer branches and then, as the season progresses, on lower crowns and inner branches of the host tree. DFTM can completely defoliate trees in one season. Defoliation can result in top and branch kill, reduced vigor, growth loss and increased susceptibility to attack by other insects and diseases, particularly Douglas-fir beetle, that can move in and kill stressed trees within 3-5 years post-outbreak of DFTM. Photographic documentation of life history can be seen in Figure 34.

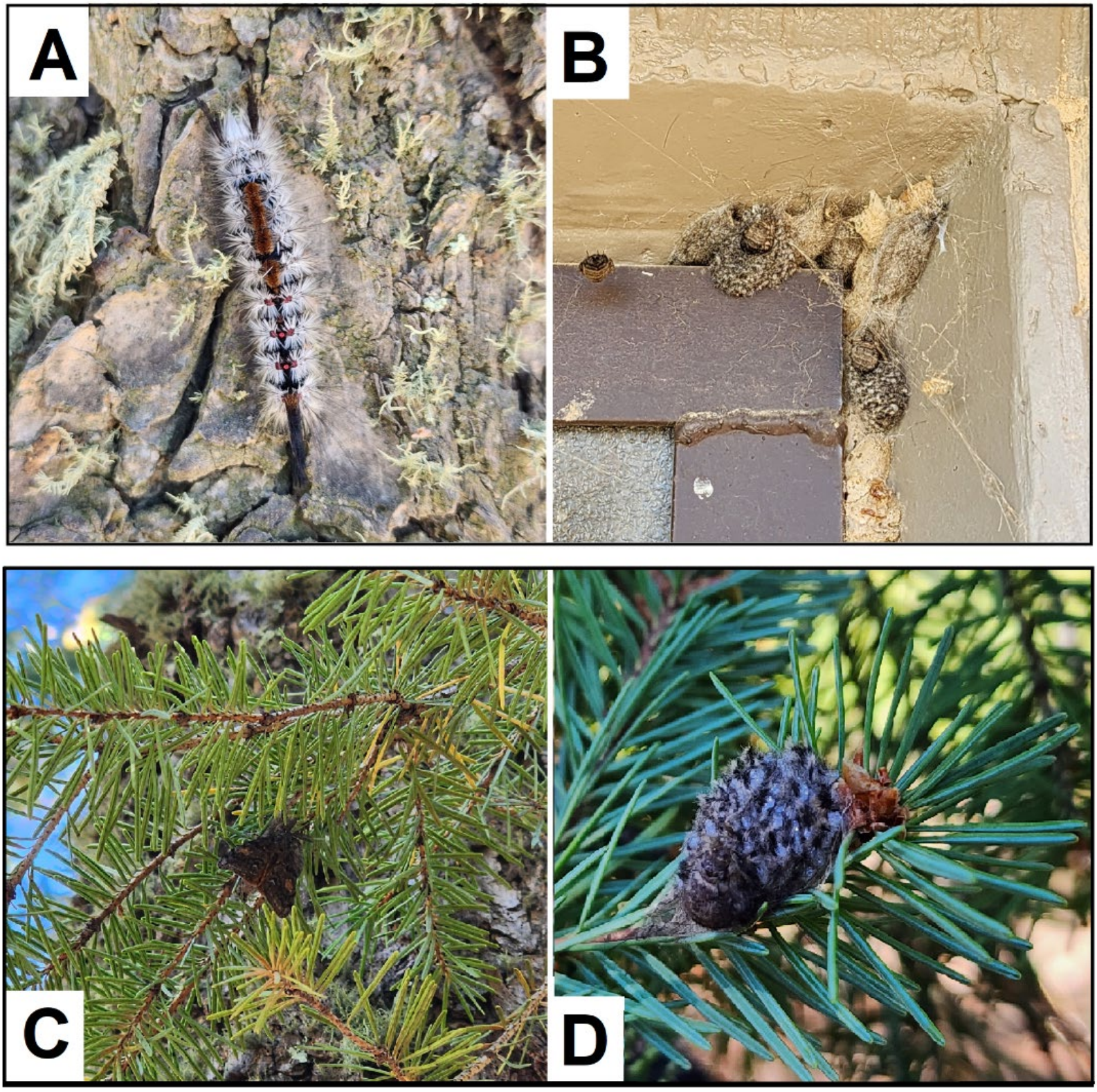

Figure 34. **A.** DFTM larva. **B.** Cocoons and egg masses with wingless female moths present on a building (pit toilet). **C.** Adult male moth. **D.** Fresh egg mass laid on top of cocoon by female. Photos by Marianne Davenport, USDA-FS.

DFTM outbreaks tend to be cyclic in nature and reach outbreak levels every 7-14 years throughout its range (10-12 years in Colorado) and typically last for 2-4 years. Several natural population regulators, including predators, parasitoids and nuclear polyhedrosis virus (NPV), cause collapse in outbreak populations. Outbreaks have been documented in the Rocky Mountain Region since the late 1930s.

In August 2023, Lakewood Service Center FHP entomologists investigated two reports of DFTM larvae on the Pike National Forest. They visited these locations and looked for larvae on other sites, surveying standing mature trees as well as regenerating Douglas-fir. They found late instar larvae, including molting 4th and growing/mature 5th instars and cocoons. Large numbers of larvae were found, but no significant defoliation. They also conducted an egg mass/cocoon survey during the fall on the Pike National Forest where the 2014-2016 outbreak occurred to gauge population levels for the coming year.

Egg mass sampling was formally conducted at 15 sites along the southern portion of Colorado's Front Range. Although many old egg masses from previous years were observed, particularly on buildings, there were very few to moderate numbers of current, viable egg masses found. At the 15 sites surveyed, no current egg masses were observed at three sites, and seven sites had fewer than five current egg masses each. Five sites had 11-13 current egg masses, and one site had 22 current egg masses (see Figure 35).

FHP expects to see increased activity and a greater number of caterpillars in the spring and summer of 2024. Caterpillars of the DFTM are very hairy. The hairs on the caterpillars as well as their egg mass and cocoons may cause an allergic reaction to some people, called "tussockosis". Itching is the most common complaint, but adverse health effects can include rashes (with welts or blisters), watery eyes, runny nose, cough and less commonly, shortness of breath, wheezing and chest tightness. With Douglas-fir tussock moth activity documented this year in Pike National Forest campgrounds, campground hosts and campers should be warned not to touch these caterpillars when they are active next year.

During the last outbreak, defoliation was observed in the 2014 Aerial Detection Survey. We anticipate that in 2023, we are one year ahead of aerial detection surveys documenting defoliation, and two years from severe defoliation across the Front Range of Colorado. Douglas-fir tussock moth management should be tailored to site conditions, level of insect activity and management objectives. Previous DFTM events in the area have resulted in as much as 30-40% tree mortality after severe defoliation. Based on how easy it was to find caterpillars in 2023, with no signs of the NPV virus, spring 2024 may be the most opportune time to manage populations over the larger area. Being that the properties visited are of differing ownerships, sizes, stand compositions, management objectives and DFTM impacts, no single management recommendation is appropriate. For more information and management recommendations, see LSC-24-03.

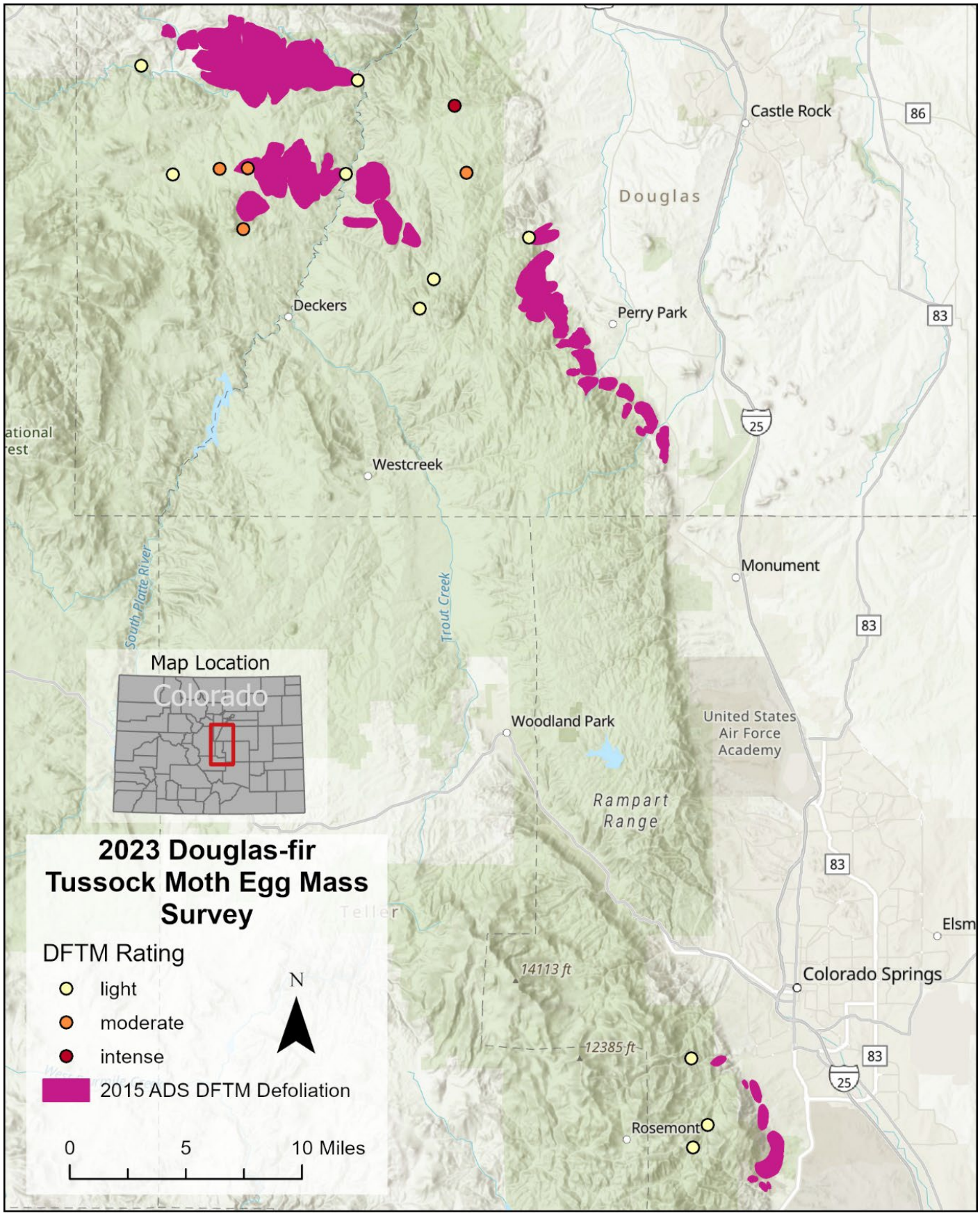

Figure 35. DFTM egg mass sampling sites with rating results for the 2023 egg mass survey (as described in Table 2). Magenta polygons represent DFTM defoliated acreage flown and mapped by Aerial Detection Survey program at the peak of the last outbreak in 2015. Map by Nathan Edberg, USDA-FS

Aspen Defoliating Insects

Western tent caterpillar *Malacosoma californicum*

Large aspen tortrix *Choristoneura conflictana*

Aspen Twoleaf Tier Moth *Enargia decolor*

Aspen defoliation/foliar damage estimates from aerial surveys plummeted from nearly 30,000 acres in 2022 to less than 6,000 in 2023 across the region, with damage occurring primarily in Colorado (Figure 36). This reduction in observed damage is likely related to the wet winter and spring experienced throughout the region in 2023. Ground observations conducted in the fall found that most mapped aspen successfully refoliated. Near Lake City, Colorado, the foliar disease ink spot and western tent caterpillar were observed to be co-occurring. Cocoons of western tent caterpillar were scattered in the aspen understory, and as observed elsewhere, most of the canopies successfully refoliated. Twoleaf tier moth is still present, but not at the outbreak levels seen in 2022.

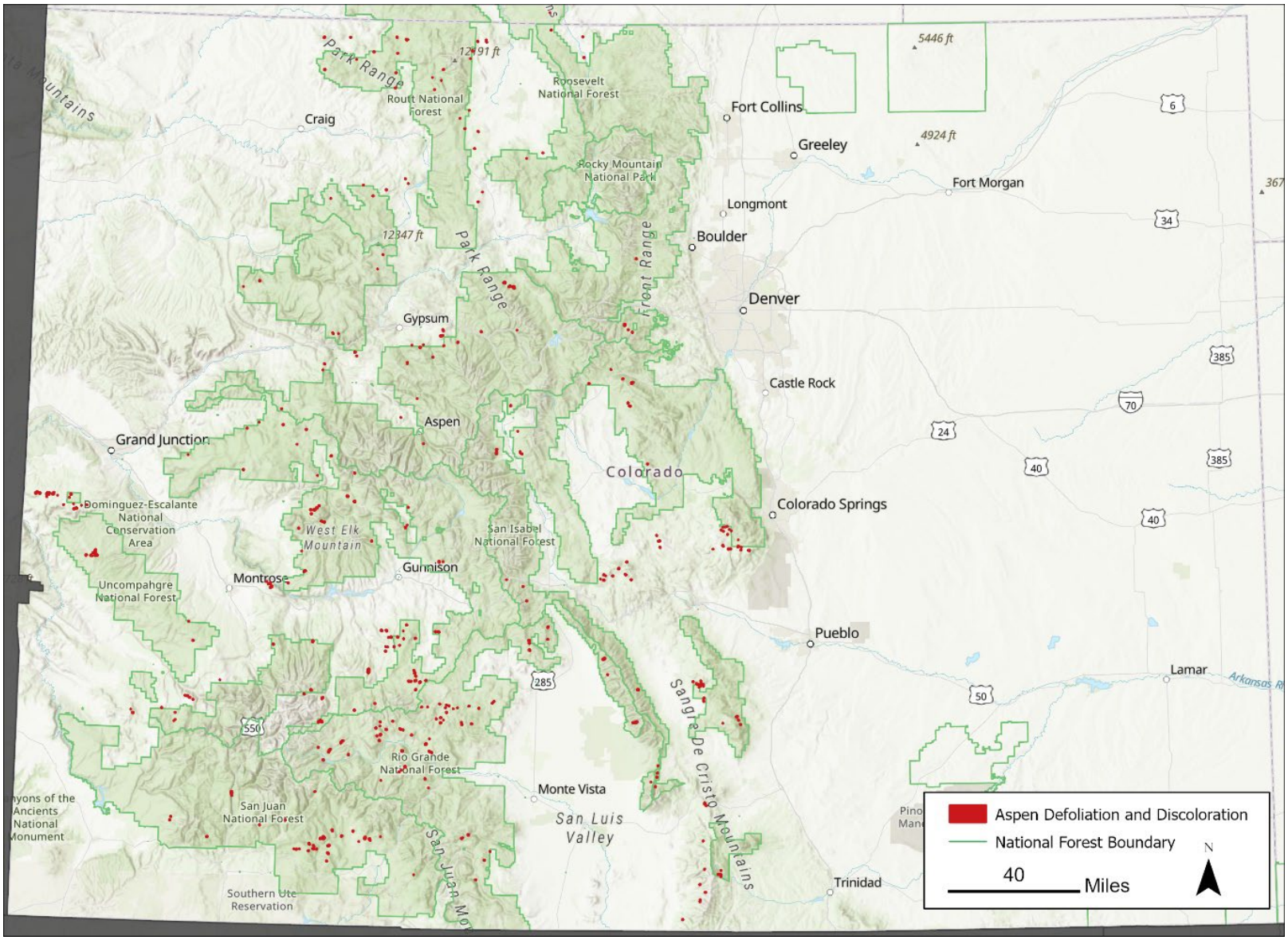

Figure 36. Aspen defoliation and discoloration in Colorado as observed from the 2023 aerial detection survey. Map by Nathan Edberg, USDA-FS.

Western Tent Caterpillar
Malacosoma spp.
Host: aspen, chokecherry and several other broadleaved tree and shrub species

Four species of tent caterpillars occur in Colorado. Known for the formation of silken shelters, or tents, in deciduous trees (Figure 37), western tent caterpillars were commonly encountered throughout the region in 2023. Heavy defoliation was observed near Durango, Colorado near Purgatory ski resort.

Figure 37. Western tent caterpillars feeding on chokecherry. Photo by Amy Lockner, USDA-FS.

Aspen Blotch Miner
Phyllonorycter tremuloidiella (apparella)
Host: aspen, cottonwood, willows

In 2021 aspen discoloration was mapped in the southeastern section of the Gunnison National Forest and was found to be caused by aspen blotch miner (Figure 38). The area continues to have a large population. The miner also infested aspen extensively in the neighboring Saguache district of the Rio Grande National Forest. Blotch miners are endemic in North America and common in Alaska and the areas around the great lakes, targeting willows and poplar species (Davis 2001). Aspen blotch miner primarily targets quaking aspen. First instars are sap feeders, while later instars feed on parenchyma and create a pouch, which they pupate in.

Figure 38. Aspen blotch miner and its galleries collected from aspen near Saguache, Colorado. Photos by Suzanne Marchetti USDA-FS.

Pine Looper

Phaeoura mexicanaria
Host: ponderosa pine

Following severe defoliation of about 4,000 acres of ponderosa pine on the Hell Canyon Ranger District in 2022, a second generation of pine looper emerged in 2023 (Figure 39) and defoliated roughly 3,650 acres on the Black Hills National Forest with about 90 additional acres mapped beyond the National Forest boundary (Figure 40). Many trees that had been defoliated in 2022 and regrown foliage were defoliated a second time in 2023 (Figure 41). In general, the defoliation that occurred in 2023 appeared to be less severe than what was observed in 2022. The pine looper population largely crashed by mid-August 2023 (Figure 42). Some additional defoliation may occur in 2024, but is expected to be minor.

Figure 39. Pine looper life stages observed on the Black Hills National Forest. Photos by Kendra Schotzko, USDA-FS.

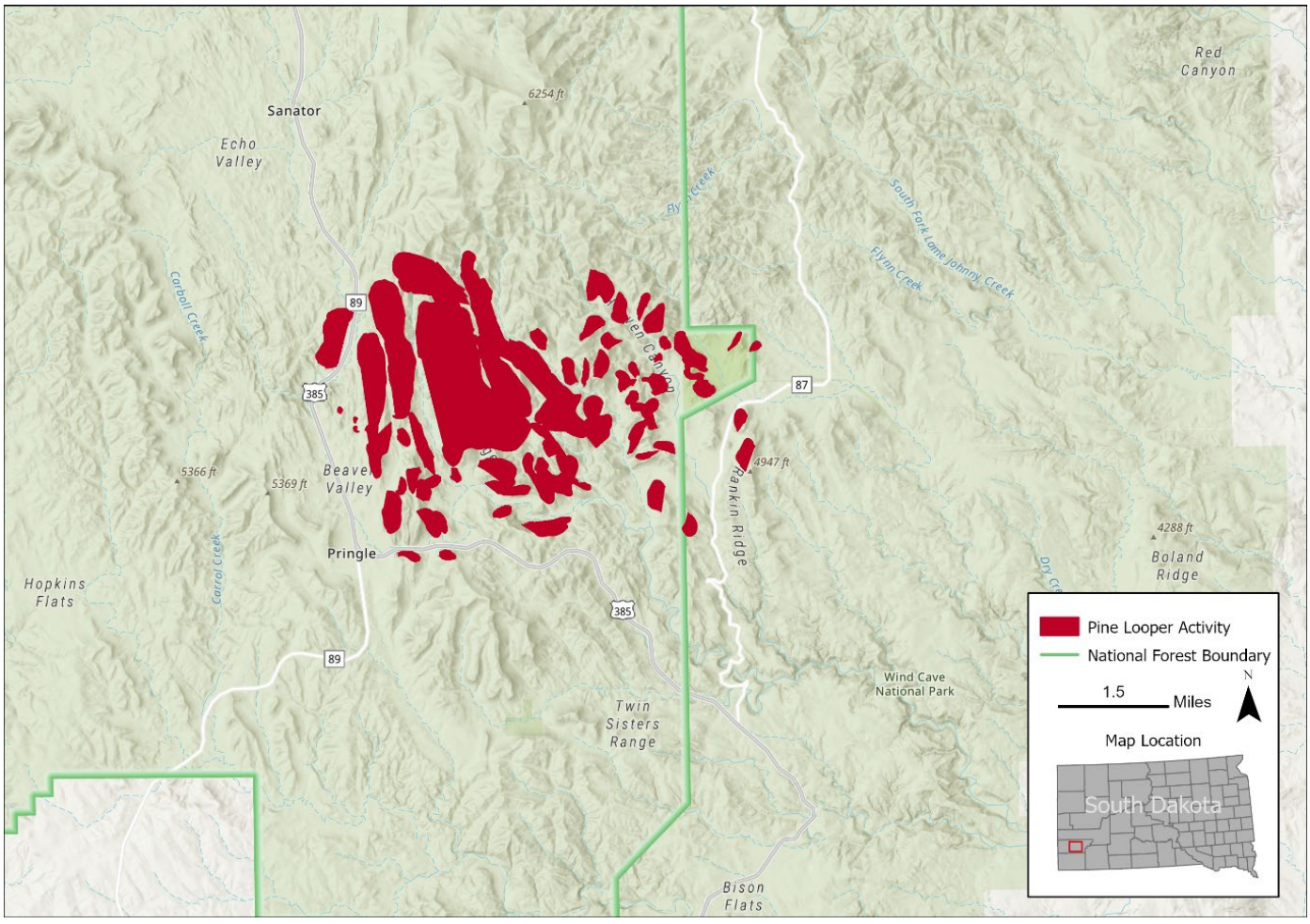

Figure 40. Area affected by pine looper defoliation on the Black Hills National Forest as observed by the 2023 aerial detection survey. Map by Nathan Edberg, USDA-FS.

Figure 41. Top row: pine looper 2022 defoliation of ponderosa pine with 2023 new needles, (left and center), and early instar pine looper feeding in spring 2023 (right) observed on the Hell Canyon Ranger District, Black Hills National Forest. Bottom row: varying intensities of pine looper defoliation of ponderosa pine, Hell Canyon Ranger District, Black Hills National Forest. Photos by Kendra Schotzko, USDA-FS.

Figure 42. Pine looper mortality and mortality agents on the Black Hills National Forest. Disease, parasites, and predators are abundant during pine looper outbreaks, including unidentified bacteria and fungal pathogen(s), and parasitic insects like Ichneumonid wasps (pictured far right). Photos by Kendra Schotzko, USDA-FS.

Status of Major Diseases

Cytospora canker on Aspen
Photo by
Brad Lalande,
USDA-FS

Status of Major Diseases

Dwarf Mistletoes

Arceuthobium spp.
Hosts: pines and Douglas-fir

Dwarf mistletoes are a group of parasitic plants that infect trees and utilize the host trees' resources to provide food and water to themselves. Five dwarf mistletoes species occur in R2, each with a specific set of hosts (Table 5) and these parasitic plants are among the most damaging forest pathogens in R2, causing extensive growth loss, deformities (including brooms and cankers) and mortality (Figure 43). Severe dwarf mistletoe infection can lead to host stress making the trees more susceptible to damaging insects or other diseases.

Table 5. Dwarf mistletoes and hosts in Region 2.

***Arceuthobium* species**	**Main hosts**
A. americanum	lodgepole pine; less common ponderosa, whitebark, limber pines
A. cyanocarpum	limber, whitebark, bristlecone pines
A. divaricatum	pinyon pine
A. douglasii	Douglas-fir
A. vaginatum subsp. *cryptopodum*	ponderosa pine; less common: bristlecone, lodgepole pines

Large wildfires over the past decade have reduced disease levels in some areas of northern CO and southern WY. Silvicultural treatments have also reduced the damage from dwarf mistletoes in the Bighorn, GMUG, Medicine Bow-Routt and Shoshone National Forests. Continued dwarf mistletoe management is highly encouraged. A dwarf mistletoe management guide is available for the region (Dwarf Mistletoes: Ecology and Management in the Rocky Mountain Region).

Figure 43. Lodgepole pine dwarf mistletoe killing the tops of lodgepole pines (left), the parasitic plant on a lodgepole pine branch (middle) and a limber pine recently killed by limber pine dwarf mistletoe (right). Photos by Jim Blodgett, USDA-FS.

Root Diseases

Armillaria Root Disease
Armillaria spp., primarily *A. solidipes* (*A. ostoyae*), *A sinapina* and *A. gallica*
Hosts: all tree species in the Rocky Mountain Region are susceptible

Tomentosus Root Rot
Onnia tomentosa and *O. leporina*
Hosts: spruce-fir (Engelmann spruce and white spruce, subalpine fir) and lodgepole pine

White Mottled Rot
Ganoderma applanatum
Hosts: aspen and various hardwood species

Heterobasidion Root Disease
Heterobasidion irregulare (*H. annosum s.s.*)
Hosts: ponderosa pine and eastern red cedar

H. occidentale (*H. parviporum*)
Hosts: White fir and occasionally subalpine fir, Engelmann and blue spruce within the distribution of white fir

Coniophora Root and Butt Rot
Coniophora puteana
Hosts: spruce-fir (Engelmann spruce and subalpine fir)

Schweinitzii Root and Butt Rot
Phaeolus schweinitzii
Hosts: Douglas-fir

Root diseases are fungal pathogens that can damage and weaken the root systems of live trees. These diseases are persistent in local areas in the forests and were observed in all tree species in R2. Root systems weakened by root diseases predispose the trees to windthrow and extreme winds continue to cause tree failures. The most common root disease pathogens associated with windthrow are *Armillaria* spp. By cover type: Armillaria root disease (Figure 44) is the most damaging root disease pathogen in all forest types followed by Tomentosus root disease (Figure 44), Artist conk (white mottled rot), Heterobasidion root disease (Figure 44) in white fir (CO) and pine (central NE), Coniophora root and butt rot (CO and WY) and Schweinitzii root and butt rot (northern WY). These diseases were all found within R2 in 2023. Symptoms and signs of root diseases may be inconspicuous or non-existent, making positive identification difficult. Summer moisture varied through R2, resulting in a lack of fruiting bodies in some locations, making it difficult to quantify root disease impacts consistently.

Figure 44. White mycelial fans caused by Armillaria root disease (left). Honeycomb decay pattern caused by Tomentosus root disease (center). Decay column in white fir caused by Heterobasidion root disease (right). Photos by Brad Lalande, USDA-FS.

Stem Decays

Red Ring Rot
Porodaedalea pini
Hosts: most conifers in the region are susceptible

White Trunk Rot
Phellinus tremulae
Hosts: aspen

Indian Paint Fungus
Echinodontium tinctorium
Hosts: true fir and Douglas-fir

Red Ray Rot
Dichomitus squalens
Hosts: ponderosa pine

Red Belt Fungus
Fomitopsis schrenkii (*F. pinicola*)
Hosts: most conifers in the region are susceptible

Stem decays are fungal diseases that cause adverse effects in all forested environments, including reducing merchantable timber and weakening the structural integrity of host trees, increasing hazardous conditions. In nature, decay fungi are vital for wood decomposition and other ecosystem services. However, in managed locations, decay fungi reduce timber quality and cause defects in trees that may lead to failure. Even in the most managed stands, trees are vulnerable to infection, as any wound or branch stub may act as an infection court. However, some species can infect stems, branches, or roots without wounding. The most prevalent species of stem decay in R2 are red ring rot (Figure 45), white trunk rot (Figure 45), Indian paint fungus (Figure 45), red ray rot (Black Hills NF) and red belt fungus in dead or dead parts of hosts. Mature, large diameter trees are more susceptible to stem decays as they have more infection courts, more heartwood, decreased ability to heal and longer potential to harbor fungi. This is especially important in developed recreation sites where continued monitoring is warranted to assess the extent of damage. Reducing wounding is the best way to prevent infection by stem decay fungi.

Figure 45. Fruiting bodies (conks) associated with *Porodaedalea pini* (left), *Phellinus tremulae* (center), and *Echinodontium tinctorium* (right). Photos by Jim Blodgett and Brad Lalande, USDA-FS.

Rusts and Cankers

Comandra Blister Rust

Cronartium comandrae

Hosts: lodgepole and ponderosa pine
Alternate hosts: bastard toadflax and northern comandra

This fungal disease causes damage mostly in Wyoming and northern Colorado. *Cronartium comandrae* requires both a hard pine host and a herbaceous alternate host to complete its life cycle. The occurrence and incidence of disease is correlated with the presence of its alternate host. Rust epidemics often follow years with a long, moist late growing season. This likely occurred this year and in recent, previous years, since twig and branch cankers were frequently observed in 2023 in the Bighorn and Shoshone NF. This can result in stem deformities, growth reduction, reduction in lumber quality and cankers that girdle branches and stems resulting in top-kill and tree mortality (Figure 46). Trees may survive several decades with dead-tops. However, top-kill can cause reductions in both growth and cone production. Infected seedlings and saplings are often killed rapidly.

Figure 46. Lodgepole pine recently killed by comandra blister rust (left), a close-up of same tree showing the perennial concentric canker ridges (middle), and a sporulating branch canker spreading into the main stem of a lodgepole pine (right). Photos by Jim Blodgett, USDA-FS.

White Pine Blister Rust
Cronartium ribicola
Hosts: limber, whitebark and Rocky Mountain bristlecone pine
Alternate hosts: currants and gooseberries (*Ribes* spp.) and species of *Pedicularis* and *Castilleja*

White pine blister rust (WPBR), caused by the exotic, invasive fungus *Cronartium ribicola*, continues to spread and intensify in R2. Favorable weather conditions over the past decade have allowed for continued expansion of the disease into previously unimpacted sites, notably on the Roosevelt (Boulder and Larimer Counties) and Pike (El Paso County) National Forests and Rocky Mountain National Park (Larimer County) (Fig 47). Branch flagging, top kill and mortality of some seedlings and saplings is occurring. In areas where the disease is well-established, such as the Medicine Bow, Bighorn, Shoshone and Black Hills National Forests, WPBR is killing and damaging trees in almost all stands.

The combined impacts of WPBR, bark beetles and climate change threaten white pines. Limber pine is listed as a “species of local concern” on the Black Hills National Forest, “species of management concern” in Rocky Mountain National Park and “Bureau of Land Management (BLM) sensitive species” in Wyoming. Whitebark pine, which occurs on the Shoshone National Forest and Wind River Indian Reservation in R2, was recently listed as threatened under the Endangered Species Act. The Species Status Assessment Report concluded that the primary stressor affecting the conservation status of whitebark pine is WPBR. Conservation and restoration strategies for whitebark pine are being promoted regionally.

Forest Health Protection has established a network of long-term monitoring plots throughout a large portion of the distribution of five-needle pines in the region (Fig 47). We are also partnering with Colorado State University, Rocky Mountain Research Station and National Park Service to develop, promote and implement improved monitoring techniques and proactive management strategies. Protecting, conserving and restoring these important species is one of FHP’s main concerns.

Figure 47. Field crews surveying *Castilleja* spp., an alternate host for WPBR, for infection on the Arapaho and Roosevelt NF (left), and a limber pine branch that was recently infected by WPBR in Rocky Mountain National Park (right). Photos by Kelly Burns, USDA-FS.

Broom Rusts of Spruce and Fir

Chrysomyxa arctostaphyli

Hosts: Colorado blue, Engelmann and white spruce

Alternate hosts: bearberry or kinnikinnick, manzanitas are occasional alternate hosts

Melampsorella caryophyllacearum

Hosts: subalpine and white fir

Alternate hosts: chickweeds

Broom rusts are caused by fungal pathogens that are common throughout the Rocky Mountain Region wherever conifer hosts occur in proximity to alternate hosts. While these diseases are very common and persistent throughout the region, incidence and severity have not been quantified recently. Infection can cause stem cankers and deformation, growth loss, top-kill and tree mortality. These diseases are collectively called broom rusts because they cause growth pattern deformities in the host trees called “brooms” and these brooms can also create an entry point for decay fungi such as *Porodaedalea pini*. Stem breakage may subsequently occur at the point of infection (Figure 48). This is particularly problematic in developed recreation sites in the region. These diseases were often found sporulating in both 2022 and 2023 in Colorado, South Dakota and Wyoming (Fig 48). This could indicate wave years with conditions favorable for sporulation are occurring and an uptick in new infections can be expected.

Figure 48. An Engelmann spruce with its top broken off at the point of infection on the Pike NF (left) and close-up of fir broom rust sporulating on the Roosevelt NF (right). Photos by Kelly Burns, USDA-FS.

Western Gall Rust
Peridermium harknessii
Hosts: lodgepole and ponderosa pine

Western gall rust is caused by a fungal pathogen and is common in all forests within R2. It spreads from pine to pine, unlike other rust species, and has no alternate host. This disease causes branch and stem galls and/or stem cankers ("hip cankers", Figure 49). Hip cankers can seriously distort the stem, significantly reducing merchantable volume. Diseased, damaged bark also creates an entry point for stem decay fungi which increases the likelihood of stem breakage. Wind snap is the greatest concern within developed recreation sites or areas with high-value targets.

Figure 49. Hip canker caused by western gall rust deforming a lodgepole pine stem (left). Stem breakage at the entry point of western gall rust canker (right). Photos by Jim Blodgett, USDA-FS.

Diplodia Shoot Blight and Canker Disease
Diplodia sapinea
Hosts: pines and other conifers

This fungal disease is most damaging in Kansas, Nebraska and South Dakota, but was recently confirmed in eastern Wyoming. It causes shoot blight, cankers, crown wilt, collar rot and root disease on trees of all ages. Damage ranges from dead shoot tips to tree mortality (Figure 50). Water deficits, competing vegetation, areas with high soil nitrogen and offsite plantings can result in increased damage. It can severely affect trees wounded by hail, snow, pruning, shearing, insects, or other damage. This disease can be identified during aerial surveys if an area is heavily damaged.

Figure 50. Scattered dead branches in a ponderosa pine caused by Diplodia shoot blight and canker disease (left), a close-up of a branch on the same tree (middle), and *Diplodia sapinea* fruiting at the base of a needle on the tree (right). Photos by Jim Blodgett, USDA-FS.

Conifer Needle Diseases

Bifusella Needle Casts
Bifusella spp.
Hosts: pine species

Lophodermella Needle Casts
Lophodermella spp., primarily *L. concolor* and *L. montivaga*
Hosts: pine species

Dothistroma Needle Blight
Dothistroma spp.
Hosts: pine species

A variety of foliage diseases occur in conifers (needle casts and needle blights) in the Rocky Mountain Region. Outbreaks occur sporadically because spread and infection are highly dependent on favorable weather conditions, typically above average moisture in the spring and/or summer. Conifer foliage diseases can significantly affect growth since conifers depend on several years of foliage and cannot refoliate like hardwoods. In 2023, no major outbreaks of conifer foliage diseases were detected by aerial surveys. However, locally heavy needle cast infection was observed on limber pine along Niwot Ridge in the Front Range (Roosevelt NF) during ground surveys. Lophodermella needle casts were observed in lodgepole pine in southwest Colorado on the Gunnison and San Juan NFs. Dothistroma needle blight was observed in several scattered areas in the Bighorn NF on lodgepole pine and in the Black Hills NF in ponderosa pine. Limber pine infected with Bifusella needle cast was observed on the Roosevelt NF (Figure 51).

Figure 51. Crown symptoms in a limber pine infected with Bifusella needle cast (left) and close-up of infected needles with visible fruiting bodies (right) on the Roosevelt NF. Photos by Kelly Burns, USDA-FS.

Common Aspen Diseases

Cytospora canker
Valsa sordida

Sooty Bark Canker
Encoelia pruinosa

Marssonina Leaf Blight
Marssonina spp.
Hosts: aspen and other poplar species

Ink Spot
Ciborinia whetzelii

In 2023 only 320 acres of aspen discoloration, which is typically caused by foliar diseases in aspen, were observed within the region by aerial surveys. This is lower than is typical in the region and is probably associated with the relatively good climatic conditions for aspen in 2023. However, mature aspen stands continue to deteriorate due to long-term drought and a multitude of biotic agents. Common mortality agents of mature aspen trees include Cytospora canker (Figure 52), sooty bark canker (Figure 52), Ganoderma root disease (Figure 52), and Armillaria root disease. throughout the region. Locally, populations of leaf diseases, such as Marssonina leaf blight and ink spot, were observed in areas with increased spring and summer moisture. Abundant regeneration was observed in recently treated areas, burned areas and stands with overstory mortality throughout the Region. Aspen regeneration monitoring projects are planned for 2024.

Figure 52. Cup-shaped (apothecia) fruiting bodies caused by sooty bark canker (left). Artist's conks on root system of failed aspen caused by Ganoderma root disease (center). Orange tendrils exuding from pycnidia within a Cytospora canker (right). Photos by Brad Lalande, USDA-FS.

Abiotic Damage

Downed Trees from Avalanches and Wind

Depending on the tree species and the size of trees broken or uprooted, avalanches or windthrow can create habitat for damaging beetles. Spruce beetle, Douglas-fir beetle and western balsam bark beetle are all attracted to downed trees and could potentially build up populations in their respective hosts, Engelmann spruce, Douglas-fir, or subalpine fir. Beetle populations built up in downed trees can move to adjacent standing host trees. The risk from bark beetles increases with the increasing size of host trees toppled and increasing abundance of standing host trees in adjacent stands. Other beetles such as engraver beetles also attack downed trees and can compete with potentially more serious bark beetles for space beneath the bark. In areas where avalanches are frequent, trees tend to be smaller and present less risk. Weather conditions, stand age and composition all influence the potential for bark beetles to move into downed trees and eventually adjacent trees. Mountain pine beetle is not attracted to downed trees, so the risk of bark beetle outbreaks is lower where downed trees occur in lodgepole or ponderosa pine stands.

On July 20, 2023, a tornado occurred on Pikes Peak, near Crystal Reservoir (Figure 53). The forested area around Crystal Creek Reservoir is composed of ponderosa pine, limber pine, Douglas-fir, Engelmann spruce and aspen. Trees of all size classes and species were impacted. The tornado uprooted many trees and caused main stem breakage (Figures 55-56). The Pikes Peak Ranger District estimates 200 acres of tree damage (Figure 54; obtained from ground survey).

Figure 53. Downed trees caused by tornado damage on Pikes Peak. Photo by Marianne Davenport USDA-FS.

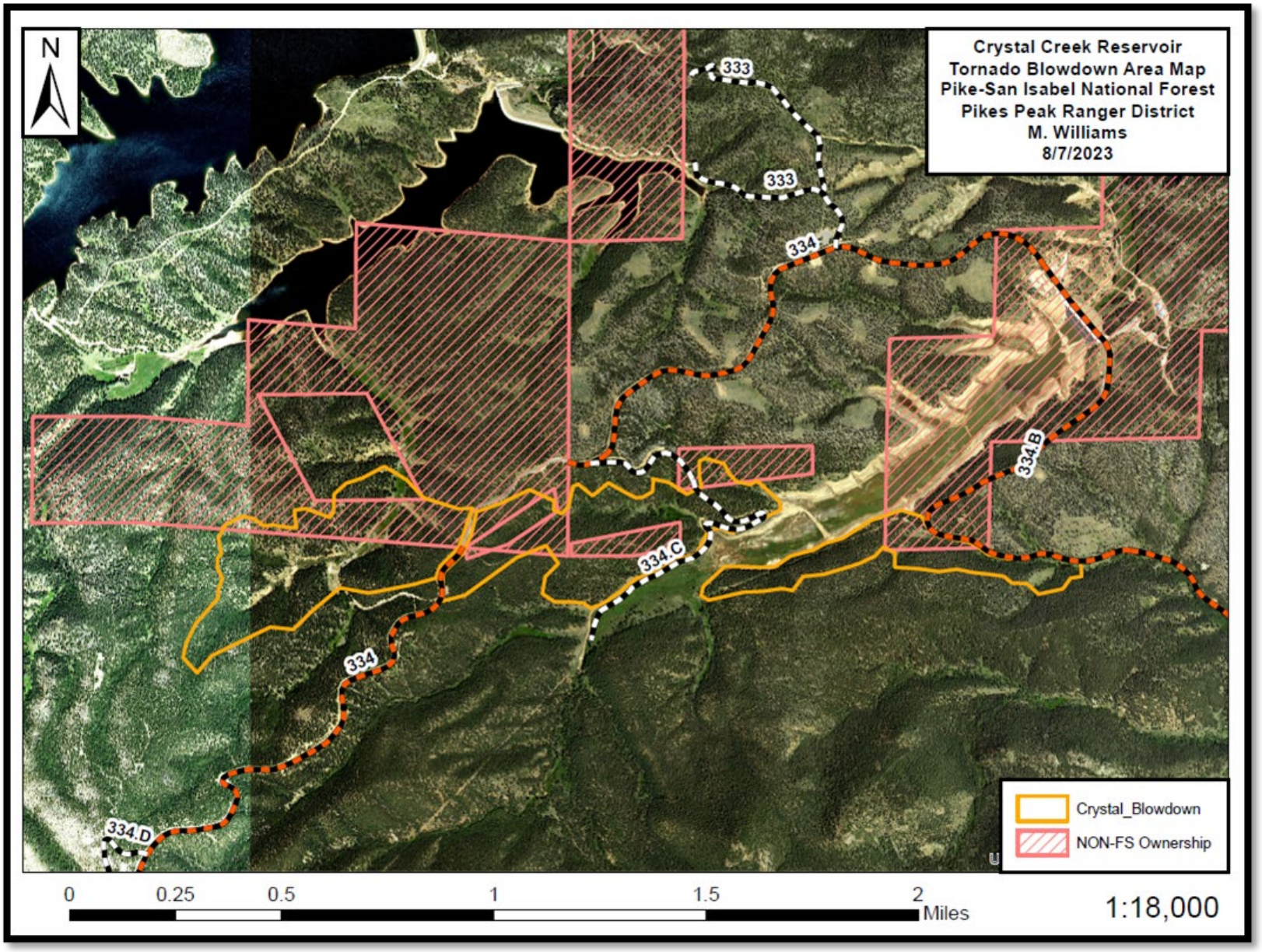

Figure 54. Map of tornado damage on Pikes Peak. Map by Matthew Williams USDA-FS.

Figure 55. Uprooted trees caused by a tornado on Pikes Peak. Photo by Marianne Davenport USDA-FS.

Figure 56. Fallen and broken aspen stems caused by a tornado on Pikes Peak. Photo by Marianne Davenport USDA-FS.

FHP Programs and Information for Managing Invasive Species

The most notable invasive forest pest of our native trees in the region is the Eurasian disease white pine blister rust, which is expanding its range in five-needle pines.

Many more invasive tree insect and disease pests affect non-native trees in our urban and planted landscapes. Some are devastating urban tree pests such as emerald ash borer, walnut twig beetle and Dutch elm disease. On our National Forest System lands, invasive plants are a serious threat to our rangelands and native plant communities.

Invasive Plant Grants to States

FHP provides limited grant funding to state agencies for assistance with the local management of invasive plants on state and private forest lands to reduce the spread of priority weeds on all forest lands.FHP does not fund invasive plant treatments on National Forest System lands. By maintaining some flexibility in the program, states can put these dollars where they can make a project or program successful. Even small grants to the local weed management boards can make a big difference. Each state handles the funds differently to support treatments and leverage state and county funding for weed programs. Our state agency partners for the invasive plants program are the Colorado Department of Agriculture, Wyoming Department of Agriculture, South Dakota Department of Agriculture-Resources, Conservation and Forestry Division, Nebraska Forest Service and Kansas Forest Service.

Other Entomology and Pathology Activities

FHP Trainings

R2 FHP staff provides annual training opportunities to resource managers on Forest Insect and Disease Identification and Management (FID) and Hazard Tree Management (HTM). We continued using a hybrid training format in 2023 in which participants attended a virtual classroom followed by an in-person field session to reduce the need for travel. In 2023, HTM field sessions were conducted on the GMUG, Pike-San Isabel, Rio Grande and White River National Forests. FID courses were conducted on the Bighorn, Black Hills, GMUG, Medicine Bow-Routt, Pike-San Isabel, Rio Grande, San Juan and White River National Forests. The virtual portions of the training sessions were recorded to improve accessibility for participants. Attendance was at an all-time high and included a diverse group of agency representatives and stakeholders (USDA-FS, National Park Service (NPS), BLM, State, universities and private companies).

In 2023, we also conducted a special field training session requested by the Boulder Ranger District (Arapaho Roosevelt NF), in collaboration with Rocky Mountain Research Station, on the biology and identification of white pine blister rust and strategies for cone collections. For more information regarding regional trainings please visit our R2 Training Website.

Hazard Tree Management Program

Various new and updated Hazard Tree Management products are available. The *Hazard Tree Evaluation* and *Tree Failure e-Forms* were updated to include a new field to write-in tree species if only genus is identified and a management/mitigation field (hazard tree) based on suggestions from users. Report templates were created for the *Hazard Tree Evaluation* and *Tree Failure Training e-Forms* to evaluate all trees assessed during surveys. Revisions were made to the *Hazard Tree Evaluation Using Survey123 Guide* (TR R2-74 Version 2) and *Tree Failures Evaluations Using Survey123 Guide* (TR R2-75) to assist users through the new reporting templates and other changes. We encourage people to use the newer Survey123 forms. We are phasing-out the Trimble forms and the Hazard Tree Database. More information is available on the Region 2 FHP Hazard Tree Management Website.

Hazard Tree Management Success Story

In 2023, GMUG NFs Supervisor's Office staff coordinated an extensive hazard tree training and evaluation process, in coordination with FHP. Nine hazard tree trainings were conducted incorporating all five districts. The process began with conversations regarding hazard tree guidance, responsibilities and management with each District Ranger and Recreation Staff Officer. The goal was to evaluate all developed recreation sites within the GMUG operated and maintained by the USDA-Forest Service. These conversations and trainings resulted in the completion of eight in-depth hazard tree evaluations, partial evaluations and mitigation at six more developed recreation sites and the removal of ~350 hazard trees throughout the forest (Figure 57). Conversations are continuing to develop protocols for vegetation management in 2024. We appreciate the hard work by the GMUG Supervisor's Office and Districts to ensure the health and safety of all who recreate on USDA-Forest Service lands.

Figure 57. Felled lodgepole pine at Middle Quartz Campground near Pitkin, CO with extensive internal decay caused by *Porodaedalea pini* (left) and white rot (center). Gunnison Service Center seasonals assisting in clean-up of standing dead aspen at Divide Forks Campground on the Uncompahgre Plateau (right). Photos by Brad Lalande, USDA-FS.

Special Forest Health Protection Projects

Evaluation Monitoring (EM)

Assessing the drivers of ponderosa pine dieback and mortality in western forests. EM-IW-2023. Kelly Burns, Jane Stewart and Seth Davis.

Special Technology Development Program (STDP)

Development of field-based diagnostic tools to identify Armillaria species. STDP-R2-2023-02. Brad Lalande, Jane Stewart, Mee-Sook Kim, Ned Klopfenstein and Jim Blodgett.

Developing tools for early detection and monitoring of high elevation pine rusts. STDP-R2-2022-01. Kelly Burns, Jane Stewart and Ashley Miller.

Biocontrol of Invasive Forest Pests (BCIFP)

Enhancing Canada thistle biocontrol: development of accurate and cost-effective tools to identify Canada thistle rust in plant tissue and soil. BCIFP-R2-20-01. Andrew Norton.

Performance curves to optimize mass rearing and field release of introduction biological control for Russian knapweed. BCIFP-R2-20-02. Paul Ode.

Publications

2023 Biological Evaluations and Service Trips

Gunnison Service Center

GSC-23-01, Damage Agents in Ponderosa Pine Plantation: Dave Wood NRA, Uncompahgre Plateau – Marchetti, Lockner, Lalande, Nelson

GSC-23-02, Bark Beetle Activity in Ponderosa Pine: Uncompahgre National Forest, Norwood Ranger District – Nelson, Lockner, Marchetti

GSC-23-03, Reducing the Risks of Bark Beetle Infestations: Five Below Timber Sale and Beaver Creek Campground, Divide Ranger District, Rio Grande National Forest – Lockner, Marchetti, Nelson

GSC-23-04, Bark Beetle Activity in Ponderosa Pine: New Beginnings Ranch, Norwood Colorado – Nelson, Marchetti, Lockner

GSC-23-05, Mesa Verde National Park Black Stain Root Disease Survey – Lalande, Marchetti

GSC-23-06, Year Three Update on the Mountain Pine Beetle Population in the Wilder-Gunnison Highlands Outbreak and Treatment Area, Gunnison Ranger District, GMUG National Forest – Lockner, Marchetti, Nelson

BE R2-23-01, Surveys of Pinyon and Juniper Mortality in Southwestern Colorado 2019-2021 – Marchetti, Lockner, Lalande, Nelson

Lakewood Service Center

LSC-23-01, USAFA Forest Health Assessment – Stokes

LSC-23-02, Walk-through Survey of Green Mountain Campground, South Platte Ranger District, Pike and San Isabel National Forests – Burns, et al

LSC-23-03, Site Assessment of the U.S. Air Force Academy – Davenport

LSC-23-04, Forest Health Assessment of Barr Camp, Pikes Peak Ranger District, Pike and San Isabel National Forests – Burns, Davenport

LSC-23-05, Site Assessment of Tornado Damage on Pikes Peak – Davenport

LSC-23-06, Site Assessment of Recreation Sites Along Highway 67 – Davenport

LSC-23-07, See LSC-24-01

LSC-23-08, See LSC-24-02

LSC-23-09, Forest Health Assessment of Buffalo Campground, South Platte Ranger District – Davenport

LSC-24-01, Site Assessment of Rabbit Ears, Dumont Lakes and Muddy Slide on the Routt National Forest – Davenport

LSC-24-02, Site Assessment of the United States Air Force Academy's Farish Recreation Area – Davenport

LSC-24-03, Douglas-fir Tussock Moth Population Status and Potential for a Front Range Outbreak. Biological Evaluation – Kruse, Davenport

LSC-24-04, Site Assessment of Recreation Sites Along CO-67, Pikes Peak Ranger District – Davenport

LSC-24-05, Forest Health Assessment of Kelsey Campground, South Platte Ranger District – Davenport, Burns

Rapid City Service Center

RCSC-23-01, Shoshone National Forest High Lakes Project Area: Forest Insect and Disease Conditions 2022 Update – Allen, Schotzko

RCSC-23-02, Bark Beetle Activity in the Crater Ridge Fire Area – Allen, Schotzko

RCSC-23-03, Limber Pine in Nebraska – Blodgett

RCSC-23-04, Limber Pine Planting in the Black Hills National Forest (2022 Update) – Blodgett

RCSC-23-05, Black Elk Limber Pine: 2020 to 2022 – Blodgett

RCSC-23-06, Black Hills National Forest Log Deck Inspection: Flax Decks – Schotzko

RCSC-23-07, Anticipated Monitoring for Pine Looper: Black Hills National Forest – Allen, Schotzko

RCSC-23-08, Pine Looper on the Black Hills National Forest: Winter 2023 Update – Schotzko

RCSC-23-09, Log Deck Inspection for South Dakota National Guard West Camp Rapid – Schotzko

RCSC-23-10, Ponderosa Pine Assessment on the Nebraska National Forest Bessey Ranger District: Spring 2023 – Allen, Schotzko, Wilson

RCSC-23-11, Pine Looper on the Black Hills National Forest: Spring 2023 Update – Schotzko

Other Reports and Peer-Reviewed Publications

Kozhar, O., Burns, K. S., Schoettle, A. W., & Stewart, J. E. (2024). Distribution of *Cronartium x flexili*, an interspecific hybrid of two fungal tree rust pathogens, in subalpine forest ecosystems of western USA. *Fungal Biology*, *128*(1), 1578-1589.

Kozhar, O., Ibarra Caballero, J. R., Burns, K. S., & Stewart, J. E. (2023). Field ready: Development of a rapid LAMP-based colorimetric assay for the causal agent of white pine blister rust, *Cronartium ribicola*. Forest Pathology, 53, e12814. https://doi.org/10.1111/efp.12814

Burns KS, Tinkham WT, Leddy KA, Schoettle AW, Jacobi WR and Stewart JE (2023). Interactions between white pine blister rust, bark beetles and climate over time indicate vulnerabilities to limber pine health. Front. For. Glob. Change 6:1149456. doi: 10.3389/ffgc.2023.1149456.

Macfarlane, W.W.; Howell, B.; Logan, J.A.; Smith, A.L.; Rasmussen, C.C; Spangler, R.E. Climate change-driven mountain pine beetle-caused whitebark pine mortality in the Greater Yellowstone Ecosystem. *Forests 2023, 14*, 2361.

Region 2 Forest Health Protection Staff

Regional Office
Kevin Khung – Director of State, Private and Tribal Forestry
Todd Neel – Assistant Director of State, Private and Tribal Forestry
Kendra Schotzko – Regional Entomologist (Acting/Detailed)
Daniel Tekiela – Invasive Plant Program Manager and Pesticide Use Coordinator

Forest Health Monitoring
Brian Howell – Forest Health Monitoring Program Manager
Nathan Edberg – GIS Specialist
Justin Backsen – Aerial Survey Program Manager
Isaac Dell – Aerial Surveyor (2)

Gunnison Service Center
John Nelson – Service Center Leader
Brad Lalande – Plant Pathologist
Amy Lockner – Entomologist
Matthew Ethington – Entomologist
Suzanne Marchetti – Biological Technician

Lakewood Service Center
Jim Kruse – Service Center Leader
Kelly Burns – Plant Pathologist
Rebecca Stokes – Entomologist
Marianne Davenport – Entomologist
Vacant – Biological Technician

Rapid City Service Center
Kurt Allen – Service Center Leader
James Blodgett – Plant Pathologist
Kendra Schotzko – Entomologist
Megan Wilson – Entomologist
Vacant – Forestry Technician

State Partners

Colorado State Forest Service – Dan West, Forest Entomologist
Kansas Forest Service – Ryan Rastok, Forest Health Coordinator
Nebraska Forest Service – Laurie Stepanek, Forest Health Specialist
South Dakota Resource Conservation and Forestry Division – Anthony Seidl, Forest Health Program Coordinator
Wyoming State Forestry Division – Harrison Brookes, Forest Health Program Manager